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Review Article

TECHNOLOGICAL INTERVENTIONS FOR INCREASING FARMERS' INCOME IN VEGETABLE PRODUCTION

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Abstract

Vegetables are important constituents of Indian agriculture and nutritional security due to their short duration, high yield, nutritional richness, economic viability and ability to generate on-farm and off-farm employment. Our country is blessed with diverse agro-climates with distinct seasons, making it possible to grow wide array of vegetables. India is the second largest producer of fruits and vegetables in the world. Total area under horticultural crops is 21.83 million hectares and production is 240.53 million tonnes. Fruits and vegetables together contribute about 92% to the total horticultural production in the country. India produces 14 % (146.5 million tonnes) of world's vegetables on 15% (8.5 million hectares) of world area under vegetables. Productivity of vegetables in India (17.3t/ha) is less than the world average productivity (18.8t/ha). Potato (28.9%), tomato (11.3%), onion (10.3%) and Brinjal (8.1%) are the 4major vegetables contributing 58.6% of total vegetable production in our country. Other important vegetables are cabbage (5.4%), cauliflower (4.6%), okra (3.9%) and peas (2.4%). India ranks first in the production of okra in the world (73% of world production). The country has witnessed tremendous progress in vegetable production, especially during the post green revolution period. Development of improved vegetable varieties/hybrids/ technologies through systematic research coupled with their adoption by the farmers and developmental policies of the government culminated in tremendous increase in area under vegetables (8.5 million ha), production (146.5 million t) and productivity (17.3 t/ha) in the country. Compared to area (2.84 million ha), production (16.5 million t) and productivity (5.8 t/ha) in 1950-1951, there had been phenomenal increase in area (2.99 folds), production (8.88 folds) and productivity (2.98 folds) of vegetables in our country during the last 6 decades. The per capita availability of vegetables is also on the increasing trend from 147.82 g/capita/day in 1991 to 230.4g/capita/day in 2011. Increasing affordability, health consciousness, urbanization, involvement of women force, market demand for high value vegetables, favourable income elasticity of demand and growth rate for domestic consumption of fruits & vegetables are some of important reasons for vegetable growth in the country (Vanitha *et al.,* 2013). Now a day, increased production and productivity is scanned under the frame of profitability of the enterprise. Being a short duration crop, vegetables are the most suitable for increasing crop intensity and income in subsistence farming. In addition to increasing productivity, off season cultivation, resource conservation, post harvest processing & value addition and integration of animal component are also utmost important for increasing profitability in vegetable cultivation. Some of the researched based findings are discussed her to illustrate the spirit of the subject.

Key words: Intercropping system, resource conservation, animal components and farmers income

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1. Increasing the income through vegetable based inter cropping systems

Inter cropping is the way to harvest the residual resources without any adverse effect on main crop and thus, it is ever beneficial than sole cropping. Many of the compatible companion crops have been found to give synergic effect on overall profitability of the production system.

a. Maize + pole type cowpea system

Some of the maize + vegetable intercropping systems have also been evaluated for working out the profitability and it was found that maize + pole type cowpea in 1:1 ratio was the best system in sense of yield of main crop (maize) and intercrop (cowpea), maize equivalent yield and B:C ratio followed by maize + Ridge gourd var. *Satputia* (1:1) (Table 1). The lucrative outcome from such intercropping systems promoted the farmers to maintained proper spacing in maize which lead to higher yield of this crop. This also forced the growers to realize the importance of proper spacing in crops in general and particularly in maize. Such participatory experiments had wide effects among the growers to adopt the technology and generate reliance upon the researchers (Mishra, 2016).

Table 1: Efficiency of Maize-Vegetables Intercropping Systems in Jharkhand

Technology Assessed	Yield / plot (q)		Yield (q/ha)		Maize-Equivalent yield (q/ha)	B:C Ratio
	Maize	Intercrop	Maize	Intercrop		
Maize as sole crop at spacing of 40 cm x 20 cm (as practiced by the farmers)	0.396	-	15.82	-	15.82	1.95
Maize (60 cm x 25 cm) + Pole Cowpea (1:1)	0.597	2.095	23.88	83.80	44.83	3.80
Maize (60 cm x 25cm) + Ridge gourd var. *Satputia* (1:1)	0.551	1.31	22.02	52.20	41.60	3.60
Maize (60 cm x 25 cm) + Cucumber (1:1)	0.515	0.295	20.60	11.80	29.05	2.50
CV (%)					9.74	
SE (m)					1.01	
CD (at 0.05)					2.07	

Note: Average sale rate of Cowpea Rs. 200/q^{-1}, Ridge gourd Rs 300/q^{-1}, Cucumber Rs. 500/ q^{-1} and maize Rs. 800/q^{-1}

b. Pigeonpea + okra systems

Pigeonpea (Arhar) is extensively grown pulse crop in Jharkhand particularly in poorly fertile, degraded rainfed uplands as sole or mixed crop with Sesame. Although, Pigeonpea suffers a large number of diseases and insect-pests and engages the land for almost whole year, the popularity of this crop in all the way is stagnant in sense of area and trade. This is because of extensive area under rainfed which would remain uncultivated if not covered under Pigeonpea. The Pigeonpea suffers a number of biotic threats like wilt, sterility mosaic disease and pod borer insects in Jharkhand. Apart from biotic challenges, the crop production in this area is still done through non-scientific traditional systems using untreated traditional seeds, without application of manures and fertilizers and plant protection chemicals. Furthermore, most degraded, dried, uncultivated and nutrient-starved lands are used for Pigeonpea cultivation in this state. All these lead poor productivity of the crop. The Agricultural Institutes in the state have recommended many technological interventions to improve the productivity of the crop *viz*., high yielding varieties (Narendra Arhar-1, Birsa Arhar-1, Malviya-13, Bahar *etc*.), Seed treatment with fungicides or *Trichoderma*, application of *Rhizobium* biofertilizer and proper NPK, line sowing at proper spacing and plant protectants for controlling diseases and insects but availability of resources at inconvenient place and time, poor conduction of information among the growers and poor socio-economic condition of the peasantry lead poor adoption of the technologies.

As a matter of perception and mindset, it was worked out that the growers would practice fertilization and intercultural operations in Pigeonpea crop only when some other crop is associated with this crop. Therefore, some most common intercrops like sorghum, sesame, groundnut and okra were planned to grow with pigeonpea for assessment of net return likely to come (Table 2). It was found that pigeonpea var. *Bahar* sown at 75 x 30 cm spacing + okra cv. Arka Anamika gave maximum Pigeonpea equivalent yield (22.46 q/ha) and B:C ratio (3.4).

c. Okra + pole type cowpea system

Vegetable cultivation is an important enterprise of small and marginal famers in irrigated lands. In general, two three sole crops of different vegetables are taken from same field in a year depending upon the availability of irrigation water. Many times sole crop does not ensure profitable yield particularly in the case of the crops vulnerable to epidemic diseases like late blight in potato and tomato, yellow vein mosaic and leaf curl diseases. In such circumstances intercropping provides a safeguard from complete loss of crop. Farmers frequently intercrop radish, broad bean, vegetable pea, rye/mustard or wheat with potato, radish, palak or coriander with tomato and brinjal and amaranth with cucurbits. Two crops of okra are taken, one in summer and another in rainy season. The summer crop remains free from major diseases and insects but that grown during rainy season has major risk of yellow vein mosaic disease and fruit borer insects. Intercropping of rainy okra with compatible crops ensures marginal gain from the crop which would otherwise lead to complete loss with the biotic stresses. In an experiment, two intercrops cowpea (pole type) and ridge gourd (*Satputia*) was compared with sole cropping of okra and it was found that okra + pole type cowpea in 1:1 ratio was most remunerative in terms of okra equivalent yield (135.17 q/ha) and B:C ratio (4.28).

Ridgegourd (*Satputia*) did not exhibit compatibility with okra because of its vigorous vining nature leading to poor fruiting in okra (Table 3) (Mishra, 2013).

Table 2: Efficiency of Pigeonpea-based Intercropping Systems in Jharkhand

Technology Assessed	Yield (q/ha)		Pigeon pea equivalent yield (q/ha)	B:C Ratio
	Main crop	Inter crop		
Mixed sowing of Pigeonpea var. Bahar and Sesame var. Kanke Safed (as practiced by the farmers)	12.2	1.45	13.40	1.6
Pigeonpea var. Bahar (75 x 30 cm) + Sorghum var. CSV-20 (1:1 Ratio)	14.3	17.2	18.89	2.8
Pigeonpea var. Bahar (75 x 30 cm) + Okra cv. Arka Anamika (1:1 Ratio)	14.5	47.73	22.46	3.4
Pigeonpea var. Bahar (90 x 30 cm) + Groundnut var. AK-12-24 (1:3 Ratio)	13.2	13.7	20.05	3.0
SE (m)			1.6	
CD (at 0.05)			3.28	

Note: Selling rate of Pigeonpea Rs. 3000/q^{-1}, Sesame Rs. 2500/q^{-1}, Okra Rs 500/q^{-1}, Sorghum Rs. 800/q^{-1}, Groundnut Rs 1500/q^{-1}

Table 3: Efficiency of okra-based intercropping systems in Jharkhand

Technology assessed	Yield. (q/ha)		Okra equivalent yield (q/ha)	B:C Ratio
	Okra	Intercrop		
Sole crop of okra at 30x15cm spacing (as practiced by the farmers)	98.45	-	98.45	3.63
Okra at recommended spacing (45x30 cm) intercropped with pole type Cowpea in alternate rows (2:1 ratio)	87.58	47.54	135.17	4.28
Okra at recommended spacing (45x30 cm) intercropped with Ridge gourd cv. *Satputia* in alternate rows (2:1 ratio)	53.60	56.57	96.023	3.23
CV (%)	-	-	5.69	-
SE (m)	-	-	1.98	-
CD (at 0.05)	-	-	4.16	-

Note: Selling rate of okra Rs.400/-q^{-1}, Ridge gourd Rs.300/q^{-1} and cowpea Rs.400/q^{-1}

2. Resource Conservation

Input cost in cultivation and market chain and demand decide ultimate income from an agricultural enterprise. Optimum use and efficient utilization of resources are the crucial aspect for increasing profit. Expenses on seed, fertilizer, irrigation water and inter-cultural operations should be well governed. The concept of precision farming is highly valid in this era of commercial farming. The effects of plastics for nursery raising, irrigation and controlling edaphic and climatic environment have been well understood for precision farming of vegetable crops.

a. Paired row planting geometry in potato

The traditional and scientifically recommended system of potato cultivation involves planting of seed tubers of 40-50g weight at 60x20 cm spacing in single row per ridge. The paired row planting geometry consisted of planting the seed tubers weighing 20±5g in 15 cm apart paired-rows on ridges spaced at 60x20 cm (centre to centre) accompanied with furrow irrigation and it was compared with traditional planting systems (single row) at variable spacing (Mishra, 2013). In another experiment, the paired-row planting geometry was compared with traditional practices comprising planting of seed tubers of white tubered cultivars *Kufri Himalini* and *Kufri Girdhari* on the ridges with single row at 60x20 cm planting distance along with drip and/or furrow irrigation systems (Mishra & Pandey, 2016). Planting the seed tubers of 20±5 g in paired rows 15 cm apart on the ridges made at 60 cm isolation (centre to centre), resulted in 244.9 q/ha tuber yield in potato cv. *Kufri Kanchan* as compared to recommended planting system of single row at 60x20 cm spacing using seed tubers of 50-60g (173.5 q/ha) and farmers' practice i.e. single row at 45x20 cm (129.6 q/ha). The seed requirement in traditional system and paired system remains the same as smaller seed tubers are used in the case of latter (Mishra, 2013).

Two varieties of potato Kufri Girdhari andKufri Himalini responded well to paired row panting geometry. Among the cultural packages paired row planting + furrow irrigation was most promising combination for tuber yield (35.2 t/ha) followed by paired row planting + drip irrigation (33.1 t/ha) in temperate Himalayas (Mishra & Pandey, 2016).

b. Use of plastic mulches and drip irrigation

Mulching with black polythene, white polythene and even dries grasses have been found to give drastic increase in yield due to conservation of soil moisture, regulation of soil temperature and suppression of weeds in hilly areas as well as plains. Polythene mulching accompanied with drip irrigation system have been found even more efficient in terms of water resource conservation. In temperate hills of Uttarakhand, mulching with black and white polythene (100 µ) and 10 cm thick bed of dried grasses accompanied with or without drip irrigation were tested in marrow (*Cucurbita pepo*) crop. Results indicated that drip irrigation was consistently superior in relation to fruit yield (694.1 q/ha) over traditional system of basin irrigation (594.5 q/ha) over two years. Mulch application resulted in 44.9-47.2% increase in fruit yield over the unmulched crop. Higher and *at par* fruit yield was realized by application of dried grass (705.1 q/ha) and black polythene mulches (704.9 q/ha). The interaction two treatment combinations indicated that black and white polythene mulches

accompanied with drip irrigation exhibited high and *at par* fruit yield in marrow (*C. pepo*) over the years (797.6 q/ha and 788.5 q/ha, respectively) (Mishra, 2017).

Similarly, black and white polythene mulches were tested in brinjal during summer-rainy seasons against unmulched treatment. Both type of polythene had enthusiastic results in regulation of soil temperature and fruit yield. White polythene owing to green house effect raised soil temperature by almost 8 ^{0}C and four times higher fruit yield (446.30 q/ha) as compared to unmulched control (24.9^{0}C and 112.22 q/ha, respectively) (Table 4).

Table 4: Effect of polythene mulching on fruit yield of brinjal during summer-rainy season

S.N.	Mulching	Mean soil temperature (^{0}C)	Biomass of weeds/m^2 (g)	Number of fruits per plant	Fruit yield per plant (kg)	Fruit yield per hectare (q)
1.	Black Polythene	30.6	45.8	20.41	1.19	330.37
2.	White Polythene	33.4	750.6	25.79	1.61	446.30
3.	Without mulching	24.9	2675.5	8.51	0.404	112.22
	CV (%)	9.3	16.4	7.5	11.2	13.2
	CD (0.05)	0.9	175.3	2.6	0.4	39.6

Drip irrigation has also been tested in onion under different doses of NPK and it was found that drip irrigation had significantly higher number of leaves per plant (9.95), leaf dry matter content (43.56%), lateral and vertical bulb diameter (6.31 cm and 8.62 cm, respectively) and bulb weight (131.49 g). However, bulb yield, specific gravity of bulbs and bulb volume was not affected significantly by irrigation system although higher values were recorded in drip system for bulb yield (403.3 q/ha) and specific gravity of bulbs (0.91 g/cm3). Three levels of NPK applied had significant influence on bulb yield. There was parallelism in increasing doses of NPK from NPK @50:40:40 kg/ha to NPK @ 150:80:60 kg/ha and bulb yield from 353.0 to 441.10 q/ha. The combined effect of irrigation systems and NPK levels had also significant impact on the all bulb yield and plant growth characters. Maximum bulb yield was registered in drip irrigation accompanied with NPK level of 150:80:60 kg/ha (453.30 q/ha) followed by sprinkler irrigation accompanied with NPK level of 150:80:60 kg/ha (428.90 q/ha) which were statistically *at par*. In the areas having limited irrigation water, drip system is equally effective for increasing bulb yield through higher level of NPK. On the basis of above findings, irrigation through drip and sprinkler and application of NPK @150:80:60 kg/ha could be recommended for higher bulb yield in onion (Mishra and Raturi, 2015).

3. Integration of animal components in cereal and vegetable-based farming

In general, animal husbandry (cattle, poultry, pigs, goats and sheep) is much important for vegetable cultivation in the view of higher nutrient required to the crops is supplemented through the manures. Some of the animal based enterprises like piggery is even more compatible with vegetable cultivation in the view of residue recycling. Vegetable residues could be used to supplement pig feed in a big way. On the basis of five years observations it was found that piggery of T&D breed was found the most compatible, viable and profitable component in baseline farming system including cereal crops + vegetables +poultry & duckery + fishery and cereal crops + vegetables + poultry in terms of net profit from piggery (Rs. 1,60,000/unit/year and Rs. 1,54,000/unit/year, respectively), net profit from farming system (Rs. 2,23000/year and Rs. 3,05,000/year, respectively) and B/C ratio (5.7 and 5.5, respectively) (Mishra & Baxla, 2015).

4. Off season cultivation of vegetables

The objective off season cultivation is to produce vegetables beyond its normal season so that higher value of the produce could be procured. Cultivation of vegetable crops in green house structures, river bed cultivation, rainy season cultivation of tomato and cucurbits are the some of the examples of off season production. Specific package of practices are required for such type of enterprises.

5. Post harvest processing and value addition

The technological interventions to induce productivity or reduce input cost may lead to higher profit from farming. However, secondary agriculture comprising processing and value addition have even more potential to raise income from farming. Therefore, infrastructural setups are very important for increasing the farm income.

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Research Article

EFFECT OF MICRONUTRIENTS ON FLORETS YIELD OF BROCCOLI (*Brassica oleracea* L. var. *italica*) IN THE TEMPERATE HIMALAYA OF UTTARAKHAND

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Abstract

The present investigation was conducted in Vegetable Research Block of Uttarakhand University of Horticulture and Forestry, Ranichauri Campus, Tehri-Garhwal (2000 m altitude, 30^0 15'N latitude and $78^0$02'E longitude), the rainfed temperate hills of Uttarakhand during spring-summer (February to June), 2013 in broccoli hybrid Calabrese (F_1). The experiment was laid out in randomized complete block design with three replications. The treatments included three foliar sprays of boric acid @ 100 ppm (T_1), zinc sulphate @ 100 ppm (T_2), ammonium molybdate @ 50 ppm (T_3), copper sulphate @ 100 ppm (T_4), ferrous sulphate @ 100 ppm (T_5), manganese sulphate @ 100 ppm (T_6), combinations of T_1 with T_2 to T_6 (T_7 to $T_{11,}$ respectively), mixture of T_1 to T_6 (T_{12}), a commercial formulation 'Multiplex' @ 100 ppm (T_{13}) and a control with no spray (T_0) as specified in table 1. The schedules of foliar spray were at fortnightly interval from 15 days after transplanting. The results indicated that higher and statistically *at par* head yield was realized with three foliar spray at fortnightly intervals of boric acid @100 ppm + zinc sulphate @ 100 ppm (408.3 q/ha) followed by boric acid @100 ppm + ammonium molybdate @ 50 ppm (383.3 q/ha) and mixture of B, Zn, Mo, Cu, Fe & Mn salt solutions (T_1 to T_6) (362.5 q/ha).

Key words: Broccoli, micronutrients, temperate Himalaya and cole crops

Introduction

Broccoli (*Brassica oleracea* L. var. *italica*) is one of most important cole crops, extensively grown in many of the temperate countries of Europe. However, it is sporadically grown in Indian sub-continent with maximum area in Himachal Pradesh followed by J&K and Uttarakhand. The health benefits of broccoli are partly associated with secondary plant compounds known for their antioxidant activity (Jones *et al.*, 2006). Prominent components of broccoli are glucosinolates (β-thioglucoside-N-hydroxy-sulfates) which are present in all members of the family Brassicaceae. Glucosinolates (GLS) and products of their breakdown are known for antifungal, bactericidal, nematicidal, and allelopathic properties (Fahey *et al.*, 2002). From the glucosinolates group, broccoli contains mostly sulforaphane, which has proven anticancer activity. It suppresses and kills Helicobacter pylori, which is responsible for ulcer disease and is considered an agent in many cases of stomach cancer (Fahey *et al.*, 2002). Vitamin C (ascorbic acid) is a very effective antioxidant which acts as an anticarcinogenic agent and reduces the risk of cardiovascular diseases (Du *et al.*, 2012). The potential antioxidant effect of vitamin C

has been the subject of many studies. Iqbal *et al.* (2004) indicate that vitamin C prevents cancer formation by inhibiting nitroso compounds in the stomach and stimulating the immune system.

The floret (head) yield in broccoli is affected by many factors including cultivars, transplanting time, nutrients and micronutrients (Ain *et al.*, 2016; Slosar *et al.*, 2016; Thapa *et al.*, 2016). Therefore, exploration of possibility to enhance productivity of this crop in Uttarakhand, a potential area of production through foliar spray of formulations of different micronutrients individually as well as in combination is indispensable.

Materials and Methods

The present investigation was conducted in Vegetable Research Block of Uttarakhand University of Horticulture and Forestry, Ranichauri Campus, Tehri-Garhwal (2000 m altitude, 30^0 15'N latitude and $78^0$02'E longitude), the rainfed temperate hills of Uttarakhand during spring-summer (February to June), 2013. The experiment was laid out in randomized complete block design with three replications. The treatments included three foliar sprays of boric acid @ 100 ppm (T_1), zinc sulphate @ 100 ppm (T_2), ammonium molybdate @ 50 ppm (T_3), copper sulphate @ 100 ppm (T_4), ferrous sulphate @ 100 ppm (T_5), manganese sulphate @ 100 ppm (T_6), combinations of T_1 with T_2 to T_6 (T_7 to $T_{11,}$ respectively), mixture of T_1 to T_6 (T_{12}), a commercial formulation 'Multiplex' @ 100 ppm (T_{13}) and a control with no spray (T_0) as specified in table 1. The schedules of foliar spray were at fortnightly interval from 15 days after transplanting. The crop of broccoli hybrid Calabrese (F_1) was raised by transplanting 30 days old seedlings in plots of 6.08 m^2 (2.7m x 2.25m) size at 45x45 cm spacing. The crop was supplemented with compost @ 15.0 t/ha and a fertilizer dose of 120:60:45 kg NPK/ha. The data were recorded on number of leaves per plant, polar head diameter (cm) equatorial head diameter (cm), head compactness (g/cm^3), head weight (g) and head yield (q/ha).

Results and Discussion

The results of this experiment indicated that there was significant effect of foliar spray of micronutrients on growth and yield of broccoli over unsprayed controlled (Table 1). The cole crops are known for their responses to micronutrient deficiencies particularly boron and molybdenum (Yang *et al.*, 2000; Thapa *et al.*, 2016). In addition to boron and molybdenum, pronounced response of zinc application has also been realized in varying soil pH (Kant *et al.*, 2013; Ain *et al.*, 2016; Slosar *et al.*, 2016). The treatments comprising foliar spray of formulations containing different micronutrients also differed significantly in relation to yield of broccoli. Among different treatments, maximum head yield was found with boric acid @100 ppm + zinc sulphate @ 100 ppm in equal quantity (408.3 q/ha) followed by boric acid @100ppm + ammonium molybdate @ 50ppm (383.3 q/ha) and mixture of B, Zn, Mo, Cu, Fe & Mn salt solutions (T_1 to T_6) (362.5 q/ha) which were statistically *at par*. Above mentioned three treatments were also promising for head weight (816.7 g, 766.7g and 725.0g, respectively), head compactness (3.8 g/cm^3, 3.5 g/cm^3 and 3.3 g/cm^3, respectively), equatorial head diameter (24.2 cm, 23.5 cm and 23.1cm, respectively) polar head diameter (22.5 cm, 21.8 cm and 21.2 cm, respectively) and number of leaves per plant (10.8, 9.6 and 9.2, respectively). This is evident from the results that foliar spray of boron, molybdenum and zinc containing molecules had favourable effect on growth and yield

of broccoli. The boron, zinc and molybdenum are important elements which work as catalyst in many physiological and biochemical reactions occurring in crop plants. The boron and zinc play pronounced role in carbohydrate metabolism and protein synthesis (Pilbeanv and Kirkby,1985; Varghese and Duraisami, 2005) whereas molybdenum is associated with N- and S-metabolism (Mendel, 2001). Significant physiological role of zinc, boron and molybdenum and positive effect on growth and yield in broccoli as well as other cole crops have been mentioned by many earlier workers including Noor *et al.* (2000), Yang *et, al.* (2000), Gupta *et al.* (2002), Goldbach and Wimmer (2007), Kant *et al*. (2013), Ain *et al.* (2016); and Thapa *et al.* (2016). The second potential group of micronutrient formulation in respect to *at par* increase head yield in broccoli were boric acid @ 100 ppm (311.2 q/ha), ammonium molybdate (287.5 q/ha), copper sulphate @ 100 ppm (284.2 q/ha), boric acid @ 100 ppm + copper sulphate @ 100 ppm and commercial formulation 'Multiplex' @ 100 ppm (283.3 q/ha), zinc sulphate @ 100 ppm (281.7 q/ha) and boric acid @ 100 ppm + manganese sulphate @100 ppm (272.2 q/ha). The increase in the head yield by the application of these micronutrients may be attributed to their role in enhancing the translocation of carbohydrates from the site of their synthesis to the storage tissue in the curd. These findings are in close conformity with the findings of Malewar (2003), Singh (2003), Pizeelta et al. (2005) and Varghese and Duraisami (2005).

On the basis of results discussed above, it could be summarized that higher and statistically *at par* head yield was realized with three foliar spray at fortnightly interval of boric acid @100 ppm + zinc sulphate @ 100 ppm in equal quantity (408.3 q/ha) followed by boric acid @100 ppm + ammonium molybdate @ 50 ppm (383.3 q/ha) and mixture of B, Zn, Mo, Cu, Fe & Mn salt solutions (T_1 to T_6) (362.5 q/ha). These treatments were also promising for other yield attributing traits *viz*., head weight, head size and head compactness in broccoli hybrid Calabrese. Therefore, three foliar spray of boric acid @100 ppm + zinc sulphate @ 100 ppm in equal quantity at fortnightly interval is recommended in summer broccoli for maximum head yield in temperate mid hills of Western Himalaya.

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Table 1: Effect of foliar spray of micronutrient formulations on growth and yield of broccoli hybrid Calabrese (F_1)

Treatments		Number of leaves per plant	Polar head diameter (cm)	Equatorial head diameter (cm)	Head compactness (g/cm^3)	Head weight (g)	Head yield (q/ha)
T_0	Control without spray	7.6	16.4	18.6	2.4	289.0	174.5
T_1	Boric Acid @100ppm	7.9	17.9	19.4	2.8	652.3	311.2
T_2	Zinc Sulphate @100ppm	7.7	16.9	19.2	2.6	573.3	281.7
T_3	Ammonium Molybdate @50ppm	8.2	18.1	20.4	2.7	575.0	287.5
T_4	Copper Sulphate @100ppm	8.6	17.5	20.1	2.3	508.3	284.2
T_5	Ferrous Sulphate @100ppm	7.8	18.2	20.5	2.7	480.0	240.0
T_6	Manganese Sulphate @100ppm	8.3	18.5	19.7	2.3	487.3	243.7
T_7	Boric Acid @100ppm + Zinc Sulphate @100ppm	10.8	22.5	24.2	3.8	816.7	408.3
T_8	Boric Acid @100ppm + Ammonium Molybdate @50ppm	9.6	21.8	23.5	3.5	766.7	383.3
T_9	Boric Acid @100ppm + Copper Sulphate @100ppm	8.3	18.6	20.3	2.9	566.7	283.3
T_{10}	Boric Acid @100ppm + Ferrous Sulphate @100ppm	8.5	17.8	19.2	2.4	476.0	258.0
T_{11}	Boric Acid @100ppm + Manganese Sulphate @100ppm	7.5	18.3	19.8	2.4	544.3	272.2
T_{12}	Mixture of B, Zn, Mo, Cu, Fe & Mn salt solutions (T_1 to T_6)	9.2	21.2	23.1	3.3	725.0	362.5
T_{13}	Commercial Formulation 'Multiplex' @100ppm	8.4	19.6	19.4	2.9	566.7	283.3
	CV (%)	11.6	12.3	12.6	9.8	13.27	17.3
	SE (m)	0.65	0.83	0.93	0.20	48.96	19.5
	CD (0.05)	1.80	2.30	2.83	0.60	139.52	54.8

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Short Communication

DEVELOPMENT OF SIMPLE AND FAST *IN VITRO* SCREENING TECHNIQUE AGAINST SALINITY IN CHICKPEA (*Cicer arietinum* L.)

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Abstract

Inhibitory effects of NaCl on tracheary element (TE) differentiation in light grown callus of chickpea were investigated to screen salinity tolerant lines. When callus was grown in MS medium containing no NaCl (control medium), upto 16% of chickpea plant cells differentiated in to tracheary elements during *in vitro* culture. Among four stains used for staining the tracheary element and nucleus , potassium permanganate and acetocarmine gave the best response. Experimental results indicated that adding 1% NaCl to the control medium reversibly inhibited the formation of tracheary element in the cells. The rate of tracheary element formation increased accordingly as the rate of cell growth in control medium and nucleus were taken dark stain. In the presence of high salt, the degree of tracheary element differentiated remained low and nucleus taken light stain through the growth cycle. The results suggest that high salt inhibit both the biosynthesis of secondary wall components and cell elongation chickpea plant *in vitro* culture.

Key words: Acetocarmine, callus, cells, *Cicer arietinum* L., potassium permanganate and stain.

Introduction

Chickpea (*Cicer arietinum* L.) is one of the most important crop of India. Like most of the other pulses, chickpea is highly sensitive to salinity. Indiscriminate use of saline irrigation water of canal resulted in disappearance of chickpea crop from its traditionally distinct cultivated areas like Haryana and Punjab (1-2). A simple and reliable method of screening of land races and germplasm is prerequisite for genetic improvement of chickpea against salinity (3-5). Therefore, studies were conducted to developed a large scale .cell based diagnostic procedure involving staining of the salt stressed cell lines derived *in vitro* from somatic tissues of chickpea.

Materials and Methods

Callus culture of chickpea genotypes viz., C-235, K-850 and CSG 8962 Kernal chana-1 were initiated from cell suspension and aseptically grown on MS medium supplemented with 0.125 mg/l, IBA+ 2.0 mg/l,BAP containing 40 g/l sucrose and solidified with 0.8% agar. Twenty days old calli were subcultured to the same medium enriched within 0%, 0.5% and 1.0% NaCl. The cultures were incubated under 8hrs photoperiod with cool white fluorescent at 25$\pm$ 1^0C. After 30 days, 1 gm of callus were placed on 70%

ethyl alcohol for 30 mins. to remove chlorophyll. After removing the chlorophyll , the tissue was redehydrated by placing into distilled water for 5-10 mins and macerated gently to break down small pieces. Small pieces of cells were taken on the slide , Few drops of stains like 1.0% acetocrmine or 1% safranin or 1.0% tetrazolum or 1% potassium permanganate were placed on cells and stirred well with needle. Slide was warmed for 1-2 minutes gently over the flame. Sample was washed by distaining solution on warm water for 2-3 times and coverslip was put gently. The cells (viable and non-viable) were examined and counted using a hemocytometer under the low magnification of a light microscope.

Results and Discussion

Microscopic assessment of cell viability is based on cytoplasmic streaming, presence of healthy nucleus and treachery element. Out of four staining solution used, 1.0% potassium permanganate and acetocarmine showed best response for staining of viable cells. This was routinely used for staining of selected cell lines. Further, this staining pattern was used to identify shape and size of the cells and nucleus in control and treatments for normal and salt adapted /tolerant cells. The cells taking round shape, dark stained nucleus and presence of secondary cell wall (Teracheary element) was treated as adapted/tolerant cells. The numbers of such cells were more in adapted cell lines.

During the prolonged culturing of callus distinct morphological changes of cells by high salt (0.5% NaCl or higher) were observed. Analysis of histological section showed many cells with thickened cell wall and nucleus taking dark colour in control callus but a general absence of cells with thickened cell walls in salt callus. Yen et al. (6) also observed similar changes. When intact cells were examined under a light microscope, some control callus had differentiated into control TEs, showing distinctive, reticulated secondary cell wall thickening characteristics of the treachery cells of xylem. Live nucleus and enlarge. elongated TEs were frequently observed Several typed of TEs, from lightly, heavily lignified, were detected in 3-week old control calli suggesting that cell continuously differentiated into TEs throughout the growth period (data not shown).

After adjusting the culture medium to contain 1.0% NaCl, cells proliferated into mostly thin walled parenchyma cells or its nucleus taken light stain. In 3 weeks old control callus, upto 16% of the cells were taking stain from acetocarmine and differentiated into TEs (Table 1). However, less than 5% of the cells differentiated into TEs in 3 weeks old salt exposed callus when cells were inoculated from control callus tissue (control salt). Three weeks old salt exposed callus, instead of control callus, was used as inoculums for fresh salt medium, nearly no TEs were observed (salt → salt). To determine whether the undifferentiated callus retained the potential for TE formation, salt exposed callus tissues were subcultured to control medium. After 3 weeks, the number of TE grown continuously and nucleus taken dark stain (salt → control table 1).

The idea indicates that high salt inhibits the formation of TEs and nucleuses were also dead. A similar cell was found in the green callus of soybean when growing in the culture medium containing 150mM NaCl (7). Reinhardt and Rost (8) also reported that high salinity reduces the width and length of vessel membranes in cotton roots.

An apparent influence of salt level on differentiation of tracheary cells in green callus of chickpea was observed. By staining with potassium permanganate and

acetocarmine, a dye that preferentially stains lignin, development of elongated, thick and spiral cells was clearly observed in cells maintained in the control medium. Cells grown in the presence of 0.5% or 1.0% NaCl had no cells with differentiated thickened spiral cell walls.

Treatment	TE/100 cells (100% differentiation)
Control	16%
Control → salt	05%
Salt→salt	01%
Salt→control	10%

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Research Article

IN VITRO ANTIMICROBIAL ACTIVITY OF SOME MEDICINAL PLANTS FROM GARHWAL REGION IN UTTARAKHAND

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Abstract

In the present study antibacterial activity of the plant extract i.e. *Bombex ceiba* Linn. (Bark & Fruit), *Berberis spp.* (Root) and *Urtica diocia* Linn. (Leaves) has been standardized for the ethno-botanical importance and to investigate the study of different plant parts extracted in different solvent system. The total five solvent systems were used for the extraction. The plant parts has been evaluated for their antimicrobial activity against *Staphylococcus aureus* MTCC- 96, *Escherichia coli* MTCC- 1610, *Salmonella abony* MTCC- 890, *Micrococcus luteus* MTCC-435, *Pseudomonas spp*., *Lactobacillus plantarum*, and against some fungal culture i.e. *Aspergillus niger* MTCC-2196, *A. fumigatus* MTCC-30, *Penicillium citrinum* and *Candida albicans* MTCC-1637.The results were found satisfactory against bacterial strain as compared to fungal strain in primary screening. .Further study MIC and MBC was evaluated against only bacterial stain. Antibacterial activity was performed by agar well diffusion method and denoted by inhibition zone diameter. Results were found very satisfactory. Almost all plant showed antibacterial activity against test organisms. These plant parts are useful in the remedy of ethnic group as well as aurvedic and traditional practioner for the treatment of various diseases.

Key Words: Antimicrobial activity, solvent extraction, minimum inhibitory concentration, zone of inhibition

Introduction

Dependence on plants as source of medicine is prevalent in developing countries where traditional medicines play a major role in healthcare (Fransworth, 1994). Current research in drug discovery from medicinal plants involves a multifaceted approach combining botanical, phytochemical, biological, and molecular techniques. Plants have been utilized as medicines for thousands of years (Samuelsson, 2004). These medicines initially took the form of crude drugs such as tinctures, teas, poultices, powders, and other herbal formulations (Balick and Cox, 1997; Samuelsson, 2004). Some of the useful plant drugs include vinblastine, vincristine, taxol, podophyllotoxin, camptothecin, digitoxigenin, gitoxigenin, digoxigenin, tubocurarine, morphine, codeine, aspirin, atropine, pilocarpine, capscicine, allicin, curcumin, artemesinin and ephedrine. A comprehensive review has described a rich diversity and use of medicinal flora within Uttarakhand (Joshi, 2002), besides a study

conducted on the medicinal plant diversity in riparian zone of River Ganga at Haridwar (Gangwar and Joshi, 2006) to understand the use of plant species from Himalayan region to cure various ailments. Previous records reveal that the herbal drugs play a major role in the treatment of wide range of diseases caused by microorganisms (Bhakuni et al., 2001). Herbs and medicinal plants can be used for community healthcare, mother and childcare through which future health of a community can be taken care.

In the present investigation it was found that almost all part of *Bombax ceiba* have been used tom treat infective condition and recommended in different diseases and it has good phytochemical properties. (Gopal, H. and Gupta, R. K.2006). Berberis has also antidiabetic (Gulfraz et al., 2008 & Ahmed, M et al., 2009) antimicrobial, edible fruits and having ayurvedic properties (Dev. et al., 2006). In the present study different solvent extracts of ethanobotanically important plants were tested against different test organisms, and the following necessary steps were undertaken to investigate their antimicrobial potential.

Material and Method

Plant Materials:
The plant materials used were dried leaves and stem bark, root and fruit of the different herbal, medicinal and aromatic plants to test their antimicrobial potential. These plants were collected from the District Rudraprayag i.e. *Bombax ceiba* (Bark & Fruit), *Berberis spp* (Root), *Urtica dioica* (leaves) of Uttarakhand state from the natural habitats. The plant parts were dried, crushed with grinder and stored in powdered form. The methodology for screening antimicrobial activity in plants as a whole or their parts was followed as mentioned by (Dahanukar and Garkal, 1995, Nair and Bhide, 1996).

Extraction of Various Fractions of the Plants

The air dried leaves, stems, root and bark of plants were soaked in ethanol, methanol, chloroform, ethyl acetate and acetone extracts of *Bombax ceiba* (Bark & Fruit), *Berberis spp* (Root), *Urtica dioica* (leaves) subjected to distillation through Liebig's condensor and the active principle remains in the round bottomed flask. The fraction or extract were collected and stored in labeled corked bottles for further investigation. Nutrient Agar Media, sabouraud's dextrose agar medium and potato dextrose agar medium were used for the antimicrobial assay. Distribution and sterilization of the medium was done as per experimental requirements and followed the methodology as given in Indian pharmacopea Vol. II 1996, and methods in Microbiology (Collins *et al.*, 1995)

Test microorganisms

The pathogenic organisms which are isolated from patients and also were brought through the Institute of Microbial Technology (IMTECH), Chandigarh, India. They were maintained as pure cultures in respective specific agar slants with periodic subculturing every 4 – 8 days in the research laboratory of Devsthali Institute of Training & Research, Dehradun.. The different pathogenic strains used in the present study *Staphylococcus aureus* MTCC 96, *Escherichia coli* MTCC 1610, *Salmonella abony* MTCC 890, *Micrococcus luteus* MTCC 435, *Pseudomonas sp.*, *Lactobacillus plantarum.* Hospital strains of *S.aureus i.e.* SA- 29, SA- 35, SA-5, SA-19, SA-8, SA-10, SA-11, SA-18, SA-21,

SA-23, SA-24 were also used as test bacterial strains apart from above culture.

Assay for Antibacterial Activity

Agar well diffusion method

About 20-25 ml of molten nutrient agar medium for each Petriplates cooled to 45^0C was added to pre-sterilize plates (150 mm in size) and allowed to solidify for 30 minutes. 0.1 ml of 12-16 hrs old culture of bacterial species was spread over the agar plates. Petri plates were allowed to dry. About 5-6 wells in each plates of 6 mm diameter were punched in the agar surface with the help of sterilized cork borer. Five wells being punched in the outer sphere for placing Acetone, methanolic, chloroform, ethyl acetate and ethanolic extract of above these plants. About 50 µl of solvent extracts of *Bombax ceiba* (Bark & Fruit), *Berberis spp* (Root), *Urtica dioica* (leaves) extracts were added in the separate wells, after incubation at 37^0C for 24 hrs the inhibition zone diameter (IZD) were measured and recorded. (Ruves *et al.*, 1978).

Table 1: List of medicinal plants, their habit and habitat, parts used and therapeutic claims

S. No.	Plant species	Habit and Habitat	Parts used	Intended Therapeutic use
1.	*Bombax ceiba* Family- Bombacaceae Local name: Semal Common Name:Silk cotton tree, red silk cotton tree, Semal Trade Name: Semal	Moderate size to large tree, from 3000-6000 ft. sub Himalayan tracts to montane zones. Himalaya, Sikkim, Nepal, Bhutan.	Stem, bark, Fruit,	Kernel used in kidney stone, bark in psycho-medicines, small branches used to stop abortion.
2.	*Berberis spp.* Family- Berberidaceae Local Name- Kingor	Medium size, 15m high deciduous tree, sub Himalayan tract to 3000-6000 ft.	Root	Anticancer, antifatigue, anticoagulant, antipyretic, local anaesthetic, antiprotozoal, anti tuberculosis, antibacterial, antitumour, anti-inflammatory and antitrachoma.
3.	*Urtica diocia* *Family*- Urticaceae common nettle or stinging nettle, Local Name- Bicchoo Ghass	Evergreen shrubs or small trees to1- 4m high. In India, Asia, Europe	Leaves with Stem	diarrhea , inflamation and dysentery, asthma, lung congestion, rash and eczema, cancer,

Bombex ceiba

Urtica diocia

Determination of Minimum Inhibitory Concentration (MIC) and Minimum Bactericidal Concentration (MBC)

The MIC and MBC value against test microorganisms of a particular extract is considered only which exhibited a maximum activity in the preliminary screening process by agar diffusion plate methods or by tube dilution broth method.

MIC determination of different solvent extract

Prepared the different sets of the sterilized broth tube i.e. nutrient broth tube for bacterial culture. Each set having seven screw cap tubes containing 25 µl of different concentration (mg/ml) viz. 200, 100, 50, 25, 12.5 and 6.25 of the crude extracts respectively. The last tube was without extract considered to be positive control showing growth. 1ml of the respective test organisms was added in each tube. Tubes having bacterial test organisms were incubated at 37^0C for 16-24 hrs. After a particular incubation period observed the tubes for the growth of inhibition. Same procedure was followed for each plant extract and each test organisms.

MBC determination

For MBC determination, including last clear tube all preceding concentration were streaked on fresh Nutrient agar plates and incubated at optimum temperature and recorded the presence or absence of microbial growth.

Results and Discussion

Screening for antimicrobial activity of various plant extracts:

Screening for antibacterial activity:

Analysing the results from experimental study it is evident that different extracts of the plant were tested against different bacterial culture, and was observed that the higher activity was shown in almost all solvent extract against all bacterial culture. Best results were obtained in ethanolic, methanolic and acetone fraction of the *Bombax ceiba* (Bark & Fruit), *Berberis spp* (Root), *Urtica dioica* (leaves). Different fractions of plants were extracted through distillation.These fractions shows antibacterial activity against different bacterial strains denoted by inhibition zone diameter against *S. aureus*, *L. plantarum*, *S. abony*, *M. luteus*, *Pseudomonas*, *E. coli*, and different hospital strain of *S. aureus*.

Ethanol extract

Ethanolic extracts of *Bombax ceiba* (Bark & Fruit), *Berberis spp* (Root), *Urtica dioica* (leaves) were active against *S. aureus(3, 33,19, & 35), M. luteus* and *S. abony* with the highest activity.

Methanol extract

Methanolic extract of *Bombax ceiba* (Bark & Fruit), *Berberis spp* (Root), *Urtica dioica* (leaves) showed activity against almost all bacterial culture. No activity was found in SA 35, *S. abony*, (*Berberis* root), SA 29, *M. luteus*, *Pseudomonas & L. plantarum* (Bombax ceiba Fruit) & SA 29, SA 35 *Pseudomonas* (*Urtica diocia* stem leaves).

Acetone extract

Acetone extract does not show activity against SA 29, *Pseudomonas* & SA 35 in (*Urtica diocia* leaves), SA 1, SA 29 in (Bombax ceiba Bark), SA 29, *E. coli 2, M. luteus*, & *Pseudomonas* in (*Bombax ceiba* fruit) & SA 29, SA 35, *S.abony*, *E.coli* 1 & *Pseudomonas* in (*Berberis* root).

Chloroform Extract

Chloroform extract was active against *M. luteus*, SA33, 19, 30,35, *S. abony & A. niger* in *Bombax ceiba* (bark), *E. coli 2, Pseudomonas, L.plantarum, S.abony* & SA 35 in *B.ceiba* (Fruit), SA 29, *E.coli* 1,2, *Pseudomonas & L. plantarum* in *Berberis* (Root), & *M.luteus* & *L.plantarum* in *Urtica diocia* (leaves).

Ethyl Acetate Extract

Ethyl acetate fraction active against SA 29, 35, *S.abony* & *E.coli* in *Bombax ceiba* (fruit), and bark extract were almost active against all strain except SA 1 & 29. In *Urtica diocia* leaves extract active against *E.coli 1&2, M.luteus, L.plantarum.* *Berberis* root was active against SA 29, *Pseudomonas, L.plantarum & E.coli* 1. Activity of different plant extract against different microorganisms shown in Table – 1.2,1.3,1.4 & Fig 1.1, 1.2, 1.3 & & 1.4

Determination of minimum inhibitory and minimum bactericidal concentration of different solvent extract of different plants, MIC/MBC levels of plant extracts against bacterial strain

Different MIC levels of acetone, ethanol, methanol and ethyl acetate fraction of different plant extracts were observed which is shown in Table 4.5. In case of MIC the concentration of plant extracts were 200 mg/ml in 1st tube, 100 mg/ml in 2nd tube, 50 mg/ml in 3rd, 25 mg/ml in 4th, and 12.5 mg/ml in 5th and 6.25 mg/ml in 6th tube. The highest inhibitions were observed in 1st concentration and lowest in 5th concentration.

Discussion

The extracts of *Bombax ceiba* (Bark & Fruit), *Berberis spp* (Root), *Urtica dioica* (leaves). Leaves and stem bark were utilized for study of antimicrobial activity. The above three plants were extracted through distillation in five solvents-Ethanol, methanol, chloroform, ethyl acetate and acetone. The extract was found highly active against bacteria in comparison to mould. The extract was used against only bacteria for further detail studies. Antibacterial activity of all three plant extracts was tested against seventeen bacterial strain both Gram-positive and Gram-negative and four fungal isolates. MIC level of those extracts of all the plants were determined having highest range of activity in preliminary screening and then compared against those microbial cultures which gave uniform results in the entire course of study.

Table 2: Preliminary Screening for antimicrobial activity of the different solvent extract of Bombax ceiba (Bark) against different bacterial strains

Plant extract Bombax ceiba (Bark)	***S. Aureus***	***A. niger***	***M. luteus***	***S. abony***	***S. aureus* hospital strain**						
					SA 3	**SA 33**	**SA 1**	**SA 29**	**SA 19**	**SA 30**	**SA 35**
Acetone Fraction	-	08	14	13	15	20	-	-	15	11	15
Chloroform Fraction	-	16	14	07	-	20	-	-	13	13	14
Methanol Fraction	-	13	13	08	15	16	-	-	15	15	16
Ethanol Fraction	-	12	18	10	16	17	-	-	10	14	13
Ethyl Acetate Fraction	-	23	15	13	14	13	-	-	13	13	13
Rifampicin 50 µg/ml			20	21	18	20	24	21	20	20	23

** Each reading is average of three wells, (-) indicate no Activity*

Table 3: Preliminary Screening for antibacterial activity of the different solvent extract of Bombax ceiba (Fruit) against different bacterial strains

Plants extracts Bombax ceiba (Fruit)	**Test Organism/Inhibition zone diameter (IZD) in mm***							
	S.aureus 29	***E.coli 2***	***M. luteus***	***Pseudomonas***	***S. aureus 35***	***L. plantarum***	***S. abony***	***E.coli 1***
Acetone Fraction	-	-	-	-	14	08	10	10
Chloroform Fraction	-	15	-	15	12	10	12	-
Methanol Fraction	-	15	-	-	10	-	09	-
Ethanol Fraction	-	10	-	10	12	-	10	15
Ethyl Acetate Fraction	10	-	-	-	13	-	11	13
Rifampicin 50 µg/ml	23	22	20	20	21	18	21	20

** Each reading is average of three wells, (-) Indicate no inhibition, Rifampicin =Positive control*

Table 4: Preliminary screening for antimicrobial activity of the different solvent extract of Berberis sp. (Root) plants extract against different Bacterial culture

Plants extracts Berberis sp. (Root)	**Test Organism/Inhibition zone diameter (IZD) in mm**						
	S.aureus 29	***E. coli 2***	***M. luteus***	***Pseudomonas***	***S.aureus 35***	***L. plantarum***	***E.coli 1***
Acetone Fraction	-	12	15	-	-	11	-
Chloroform Fraction	15	15	-	14	-	10	17
Methanol Fraction	12	10	15	15	-	18	27
Ethanol Fraction	15	12	15	17	-	15	25
Ethyl Acetate Fraction	10	-	-	10	-	10	15

Table 5: Preliminary screening for antimicrobial activity of the different solvent extract of Urtica diocia (stem leaves) against different Bacterial culture

Plants extracts Berberis sp. (Root)	**Test Organism/Inhibition zone diameter (IZD) in mm**							
	S. aureus29	***E. coli 2***	***M. luteus***	***Pseudomonas***	***S. aureus35***	***L. plantarum***	***S. abony***	***E. coli 1***
Acetone Fraction	-	15	15	-	-	14	12	17
Chloroform Fraction	-	-	16	-	-	17	-	15
Methanol Fraction	-	10	17	-	-	12	13	13
Ethanol Fraction	-	15	15	11	-	-	12	15
Ethyl Acetate Fraction	-	10	17	-	-	09	-	18

Table 6: Determination of MIC and MBC of different solvent extract of different plants against different bacterial cultures

Plants extracts (Solvent)	MIC against Bacterial Strain (mg/ml)							
	S. aureus 35	S. aureus 19	*M. luteus*	L. plantarum	S. aureus 29	Pseudomonas	S. abony	E. Coli
Bombax ceiba (Bark) Ethyl acetate	50 (100)	50 (100)	50 (100)	-	-	-	50 (100)	-
Bombax ceiba (Bark) Acetone	25 (50)	25 (50)	50 (100)	25 (50)			50 (100)	-
Berberis (Root) Ethanol	-	-	50 (100)	100 (200)	50 (100)	25 (50)	-	12.5 (25)
Berberis (Root) Methanol	-	-	50 (100)	50 (100)	100 (200)	50 (100)		12.5 (25)
Urtica diocia Methanol	-	-	50 (100)	100 (200)	-	-	100 (200)	50 (100)
Urtica diocia Acetone	-	-	50 (100)	100 (200)	-	-	100 (200)	50 (100)

(-)= No inhibition, ( ) =MBC shown in parenthesis

CONCLUSION

Medicinal plants have the solution to a majority of the diseases challenging mankind. Herbs can be used effectively for both preventive and curative care of a community in poor health. Herbs and medicinal plants are selectively available to the rural people. Limited research has been done to improve the role of medicinal plants and herbs in the daily life of the population at large. The need for microbiology and biotechnology research to make available the prospects of herbal treatment for good health of rural people. There is a need to grow medicinal plants in rural and tribal areas for easy availability.

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Research Article

SEASONAL INCIEDENCE OF PAINTED BUG, *BAGRADA HILARIS* OF SOME BRASSICA SPECIES WITH RESPECT DATES OF SOWING

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Abstract

Field experiment was conducted in order to study the population dynamics of painted bug on different varieties of *Brassica* spp. at different dates of sowing at Crop Research Centre (CRC) of G.B. Pant University of Agriculture and Technology, Pantnagar (India). Eight spp. of *Brassica* including *Brassica campestris* cv. BSH-1, *Brassica alba*, *Brassica carinata*, *Brassica nigra*, *Eruca sativa* cv. T-27, *Brassica juncea* cv. Varuna, YST-151 and GSC-6 were sown on five dates of sowing starting from October 3 to December 3, 2015 at fifteen *days interval*. The data on the seasonal incidence of the *B. hilaris* on the different sown mustard crop during Rabi seasons of 2015-16 revealed that the infestation of the pest on the crop occurs in two distinct peaks i.e., one at the seedling stage and other at the crop maturity stage *B. alba* and *B. nigra* species harboured relatively higher population of painted bug than other Brassica spp. i.e. these varieties are more susceptible to painted bug.

Keywords: Painted bug, dates of sowing, seasonal incidence, brassica and mustard.

Introduction

Rapeseed-mustard constitutes an important group of oilseed crops next only to groundnut and contributes substantially to the country requirement of edible oils. About 50 insect species have been found infesting rapeseed-mustard in India (Sharma and Singh, 2010). Among which, the painted bug *Bagrada cruciferarum* Kirkaldy now known as *Bagrada hilaris* (Burmeister), (Hemiptera: Pentatomidae) is an important pest of crucifer crops in India (Rai, 1976 and Singh, 2008) and abroad throughout world(Reed *et al.*, 2013). It is a serious pest of rapeseed mustard and found active during seedling stage (October-November) (Vora *et al.*, 1985) and at harvest stage (March-April) (Singh and Malik, 1993 and Singh, 1996). The painted bug has been reported active throughout the year and infest various crucifers during winter where it causes considerable damage (Batra, 1958 and Sandhu, 1975). Both nymphs and adults suck cell sap from leaves at seedling stage and developing pods, which gradually wilt and dry up. Leaves of young plants develop white spots due to bugs feeding. Severe attack at seedling stage may even kill the plants and bear a brunt-up look. The loss attributed at seedling stage due to painted bug attack varied from 26.8 to 70.8 per cent. The attack at the pod formation and maturity stages is much more alarming as it results in losses to the tune of 30.1 per cent in

yield and 3.4 per cent in oil content (Singh *et al.,* 1980)

Materials and Methods

The seasonal incidence of *B. hilaris* was recorded on *Brassica campestris* cv. BSH-1, *Brassica alba*, *Brassica carinata*, *Brassica nigra*, *Eruca sativa* cv. T-27, *Brassica juncea* cv. Varuna, YST-151 and GSC-6. Five different sowing dates, October 3 (First sowing), October 18(Second sowing), November 3(Third sowing), November 18 (Fourth sowing) and December 3(Fifth sowing) were selected for raising the crop at Crop Research Centre (CRC) of G.B. Pant University of Agriculture and Technology, Pantnagar, during 2015and 2016. The recommended agronomic practices were followed. The plot size was 4.2m x 3m and the row to row and plant to plant distances as 30 cm and 10 cm, respectively. The observations were made on weekly basis. Weekly observations on total population of nymphs on 5x 5 m^2 area of plot were recorded at initial stage of crop and at fully grown plant stage.

Result and Discussion:

The pest remained active on the crop at the seedling and maturity stage of the crop during the period of study (October to February, 2015-16) i.e. during 41th to 7th standard week (SW).

First Sown (October 3) - The perusal of data presented in Table 1 on screening of some brassica spp. against painted bug on the basis population count (nymph + adult) revealed that the incidence of *B. hilaris* was started from the 41th standard week (SW). During this week significantly maximum mean population was recorded on BSH-1(1.66 bugs/25m^2 area). It was on par with YST-151(0.66 bugs/25m^2 area), *B. carinata*, *B. nigra*, T-27(0.33 bugs/25m^2 area). While no population was recorded on Varuna, GSC-6 and *B. alba.*

The incidence of B. *hilaris* was found increasing from 45th onwards and the maximum peak of population was recorded during 47th SW. During this week significantly highest mean population was recorded on *B. alba*(5.33 bugs/25m^2 area) and which was on par with BSH-1(2.33 bugs/25m^2 area), YST-151 and Varuna (1.33 bugs/25m^2 area). While lowest mean population was recorded on *B. nigra*(0.33 bugs/25m^2 area).

Second sown (October 18) - *B. hilaris* on second sown rapeseed-mustard crop Cv. *B. carinata* revealed that the pest was active during the seedling and maturity stage of the crop (Table 2). During the crop period two peaks of painted bug population were observed on 47th SW (1.66 bugs/25m^2 area) and 8th SW (1.0 bugs/25m^2 area).

Third sown (November 3) - Peak populations of painted bugs were recorded during 52nd and 50th SW with number as high as 5.33 and 3.66 bugs per 25m^2 area, respectively. Nevertheless, the population of painted bugs remained quite high during 48th to 50th SW (0.33 to 3.66 bugs/25m^2 area) and again during 51th to 52th SW (2.0 to 5.33 bugs/25m^2 area).

Fourth sown (November 18)- The pest remained active on the crop at the early and later stage of the crop during the period of study (December to February, 2015-16) i.e. during 52nd to first SW and 4th to 9th SW. Peaks of *B. hilaris* populations were observed during the seedling stage and at maturity stage . Peak populations of painted bugs were recorded during 1st and 9th SW with number as high as 1.66 and 7.33 bugs per 25m^2 area, respectively.

Fifth sown (December 3) –The data presented in Table 5 of B. hilaris on fifth sown Brassica Spp. B.carinata,YST-151,T-27,B.alba revealed that the pest was active during the seedling and maturity stage of the crop . During the crop period two peaks of painted bug population were observed on 1st SW (5.66 bugs/25m^2 area) and 7th SW (5.0 bugs/25m^2 area).

Table 1: Incidence of *B. hilaris* on first sown brassica spp. during different standard weeks in the year 2015-16

Treatment	Standard week						
	41	**42**	**43**	**44**	**45**	**46**	**47**
BSH 1	1.66 (0.74)	0.0 (0)	1.0 (0.80)	0.66 (0.47)	2.0 (0.81)	2.0 (1.15)	2.33 (1.21)
YST 151	0.66 (0.66)	2.66 (1.60)	0.33 (0.33)	0.0 (0)	0.66 (0.66)	2.66 (1.57)	1.33 (0.94)
Varuna	0.0 (0)	0.66 (0.47)	0.33 (0.33)	0.33 (0.33)	3.0 (1.0)	3.66 (1.82)	1.33 (0.66)
GSC 6	0.0 (0)	2.33 (1.24)	0.66 (0.66)	0.0 (0)	0.0 (0)	0.0 (0)	0.0 (0)
B. carinata	0.33 (0.33)	0.66 (0.47)	0.66 (0.66)	0.0 (0)	0.0 (0)	0.33 (0.33)	0.0 (0)
B. nigra	0.33 (0.33)	1.66 (1.04)	0.33 (0.33	0.0 (0)	2.0 (0.81)	4.0 (1.85)	0.66 (0.47)
T 27	0.33 (0.33)	1.0 (0.80)	0.0 (0)	0.0 (0)	2.66 (1.28)	3.66 (1.52)	0.0 (0)
B. alba	0.0 (0)	1.66 (1.27)	0.33 (0.33)	0.66 (0.47)	0.33 (0.33)	12.66 (2.85)	5.33 (1.33)
Mean	0.41 (0.30)	1.33 (0.86)	0.45 (0.43)	0.20 (0.15)	1.33 (0.61)	3.62 (1.38)	1.37 (0.57)
Sem	0.62 (0 .33)	0.72 (0.41)	0 .35 (0.33)	0.35 (0.26)	1.53 (0.56)	4.03 (0.72)	2.08 (1.89)
Cd at 5%	1.88 (1.02)	2.19 (1.26)	1.08 (1.0)	1.0 (0.80)	4.64 (1.70)	12.23 (2.20)	6.32 (1.89)
Cv	258.56 (194.48)	93.83 (83.61)	135.71 (132.67)	298.56 (288.51)	198.85 (158.26)	192.76 (90.54)	262.64 (187.24)
F-value	NS	NS	NS	NS	NS	NS	NS

**Figures in the parentheses are $(n+0.5)^{1/2}$ transformed values*

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Table 2: Incidence of *B. hilaris* on second sown brassica spp. during different standard weeks in the year 2015-16

Treatment	Standard week				
	44	**45**	**46**	**47**	**8**
BSH 1	0.0 (0)	0.66 (0.47)	0.66 (0.66)	1.66 (1.04)	0.0 (0)
YST 151	0.66 (0.47)	0.0 (0)	0.33 (0.33)	1.33 (1.13)	0.0 (0)
varuna	0.0 (0)	0.0 (0)	0.33 (0.33)	1.33 (1.13)	0.0 (0)
GSC 6	0.0 (0)	0.0 (0)	0.33 (0.33)	0.33 (0.33)	0.0 (0)
B. carinata	0.0 (0)	0.33 (0.33)	0.66 (0.47)	0.33 (0.33)	1.0 (0.80)
B. nigra	1.33 (0.94)	0.0 (0)	0.66 (0.47)	1.0 (0.57)	0.0 (0)
T 27	0.66 (0.47)	0.0 (0)	0.66 (0.47)	0.33 (0.33)	0.0 (0)
B. alba	0.66 (0.47)	0.0 (0)	1.0 (0.80)	1.0 (0.80)	0.0 (0)
Mean	0.41 (0.29)	0.12 (0.10)	0.58 (0.48)	0.91 (0.71)	0.12 (0.10)
Sem	0.49 (0.35)	0.24 (0.18	0.45 (0.35)	0.61 (0.39)	0.20 (0.14)
Cd at 5%	1.50 (1.06)	0.75 (0.57)	1.37 (1.07)	1.85 (1.19)	0.61 (0.45)
Cv	206.18 (206.18)	343.64 (326.94)	134.22 (126.03)	115.40 (95.51)	282.84 (255.53)
F-value	NS	NS	NS	NS	S

**Figures in the parentheses are $(n+0.5)^{1/2}$ transformed values*

Table 3: Incidence of *B. hilaris* on third sown brassica spp. during different standard weeks in the year 2015-16

Treatment	Standard week						
	44	**48**	**49**	**50**	**51**	**52**	**5**
BSH 1	1.66 (1.04)	1.0 (0.57)	0.66 (0.47)	0.33 (0.33)	0.0 (0)	0.0 (0)	0.0 (0)
YST 151	1.0 (0 .57)	1.33 (0.91)	1.0 (0.80)	3.66 (1.81)	0.0 (0)	0.0 (0)	0.0 (0)
varuna	1.66 (0.74)	1.66 (1.04)	1.66 (1.04)	0.0 (0)	0.0 (0)	0.0 (0)	0.0 (0)
GSC 6	3.33 (1.60)	0.33 (0.33)	0.33 (0.33)	0.33 (0.33)	0.0 (0)	0.0 (0)	0.0 (0)
B. carinata	1.0 (0.80)	1.33 (0.66)	1.66 (1.04)	0.33 (0.33)	0.0 (0)	3.0 (1.39)	0.0 (0)
B. nigra	2.66 (1.28)	0.33 (0.33)	0.66 (0 .47)	0.33 (0.33)	2.0 (0.81)	5.33 (1.85)	0.0 (0)
T 27	0.0 (0)	0.33 (0.33)	0.66 (0 .47)	0.0 (0)	0.0 (0)	0.0 (0)	0.0 (0)
B. alba	1.33 (1.13)	0.66 (0.47)	0.33 (0.33	0.0 (0)	2.0 (0.81)	0.0 (0)	2.33 (1.21)
Mean	1.58 (0.90)	0.87 (0.58)	0.87 (0.62)	0.62 (0.39)	0.50 (0.20)	1.04 (0.40)	0.29 (0.15)
Sem	1.27 (0.51)	0.66 (0.41)	0.57 (0.38)	0.56 (0.28)	1.03 (0.42)	1.32 (0.44)	0.51 (0.23)
Cd at 5%	3.85 (1.56)	2.0 (1.25)	1.74 (1.17)	1.72 (0.87)	3.13 (1.28)	4.0 (1.35)	1.55 (0.70)
Cv	138.93 (99.40)	131.07 (122.55)	113.94 (107.77)	157.60 (127.0)	358.56 (358.56)	219.71 (190.38)	305.05 (262.91)
F-value	NS	NS	NS	S	NS	S	S

**Figures in the parentheses are $(n+0.5)^{1/2}$ transformed values*

Table 4: Incidence of *B. hilaris* on fourth sown brassica spp. during different standard weeks in the year 2015-16

Treatment	Standard week			
	52	1	4	9
BSH 1	0.0 (0)	0.0 (0)	0.0 (0)	0.0 (0)
YST 151	0.0 (0)	0.0 (0)	0.0 (0)	0.0 (0)
Varuna	0.0 (0)	0.0 (0)	0.0 (0)	0.0 (0)
GSC 6	0.0 (0)	1.66 (1.0)	0.0 (0)	0.0 (0)
B. carinata	0.0 (0)	1.0 (0.80)	0.0 (0)	0.0 (0)
B. nigra	1.0 (0.80)	0.0 (0)	0.0 (0)	5.33 (2.26)
T 27	0.0 (0)	0.0 (0)	0.0 (0)	7.33 (2.68)
B. alba	0.0 (0)	0.0 (0)	1.66 (1.04)	1.66 (0.74)
Mean	0.12 (0.10)	0.33 (0.22)	0.20 (0.13)	1.79 (0.71)
Sem	0.20 (0.14)	0.47 (0.25)	0.31 (0.18)	0.81 (0.27)
Cd at 5%	0.61 (0.45)	1.44 (0.78)	0.94 (0.57)	2.47 (0.83)
Cv	282.84 (255.53)	248.20 (197.48)	259.22 (248.67)	78.81 (66.78)
F-value	S	NS	S	S

**Figures in the parentheses are $(n+0.5)^{1/2}$ transformed values*

Table 5: Incidence of *B. hilaris* on fifth sown brassica spp. during different standard weeks in the year 2015-16.

Treatment	Standard week		
	1	6	7
BSH 1	0.0 (0)	0.0 (0)	0.0 (0)
YST 151	0.0 (0)	3.33 (1.79)	0.0 (0)
Varuna	0.0 (0)	0.0 (0)	0.0 (0)
GSC 6	0.0 (0)	0.0 (0)	0.0 (0)
B. carinata	1.33 (0.91)	0.0 (0)	0.0 (0)
B. nigra	0.0 (0)	0.0 (0)	0.0 (0)
T 27	0.0 (0)	0.0 (0)	5.0 (2.18)
B. alba	5.66 (2.33)	1.0 (0.80)	0.0 (0)
Mean	0.87 (0.40)	0.54 (0.32)	0.62 (0.27)
Sem	0.58 (0.20)	0.36 (0.16)	0.54 (0.11)
Cd at 5%	1.77 (0.60)	1.10 (0.49)	1.63 (0.35)
Cv	115.63 (85.68)	116.58 (87.72)	149.66 (73.92)
F-value	S	S	S

**Figures in the parentheses are $(n+0.5)^{1/2}$ transformed values*

The data on the seasonal incidence of the *B. hilaris* on the different sown mustard crop during Rabi seasons of 2015-16 revealed that the infestation of the pest on the crop occurs in two distinct peaks i.e., one at the seedling stage and other at the crop maturity stage. The activity of the pest at the seedling stage was observed between 41th and 52nd SW with its peak population noticed on 46th SW. The bug population again appeared on the crop at the maturity stage on 7th SW with increase and it reached its maximum population on 9th SW. Similar peaks in the *B. hilaris* infestation on the early sown mustard crop were earlier reported by Singh and Malik (1993) and Nagar et al. (2011) .The maximum population during seedling stage was observed on 46th SW, whereas the peak population at the maturity stage was reached between 7th and 9th SW. The results of the present studies got support from observations recorded by Joshi et al. (1989) as they observed painted bug population at higher densities on the crop sown 1st and 15th November. It can be concluded that all different sown brassica spp. the infestation of the *B. hilaris* occurs in two distinct phases with a peak at seedling and maturity stage of the crop.

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