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ECONOMIC ANALYSIS OF FOLIAR APPLIED BIO-REGULATORS FOR SEED PRODUCTION IN FORAGE COWPEA [*Vigna unguiculata* (L.) Walp.] CULTIVARS UNDER PUNJAB CONDITIONS

Balwinder Kumar[1] and R.S. Sarlach[2]

[1]*Forage Section, Dairy Farm, Department of Animal Genetics and Breeding, GADVASU, Ludhiana, 141004, Punjab*

[2]*Department of Plant Breeding and Genetics, Punjab Agricultural University, Ludhiana, 141004 Punjab*

ABSTRACT

The experiment was conducted during the year 2008 and 2009 at the Fodder Farm of Guru Angad Dev Veterinary and Animal Sciences University, Ludhiana, Punjab, India to find out the economics of bio-regulators in two cultivars of fodder cowpea under irrigated conditions of Punjab. Cultivar CL 367 recorded significantly higher seed yield, gross return, net return and benefit-cost ratio than Cowpea 88. The seed yield of forage cowpea was increased significantly by three foliar application of 50 µg/ml of salicylic acid at weekly interval staring from the flower initiation. The maximum net profit of Rs. 30488/ha was obtained with the three foliar application of salicylic acid at 50 µg/ml followed by 2% KNO_3 (Rs. 27888/ha) as compared to control. Foliar application of salicylic acid at 50 µg/ml recorded significantly higher benefit cost ratio (1: 2.39) than all other bio-regulators and control due to increase in the seed yield. Higher concentration of salicylic acid (100 µg/ml) significantly reduced the seed yield, net return and benefit cost ratio. Among different bio-regulators sodium benzoate at 100 and 150 µg/ml were found least effective in increasing the seed yield but recorded good returns than foliar application of $CaCl_2$ (0.5% and 1%) due to its lower cost.

Key words : *Benefit-cost ratios, bio-regulators, cowpea, economics, salicylic acid, seed yield*

Cowpea [*Vigna unguiculata* (L.) Walp.] is an important multipurpose ancient leguminous crop, which has been grown in arid and semi-arid regions of South Asia, Africa, Latin America and in the Southern United States. The seeds are a major source of plant proteins and vitamins for man, feed for animals, and also a source of cash income. As a forage crop, cowpea is quick growing, high yielding, with substantially rich biomass production and helps to maintain the milk production in milch animals during heat stress period (1). For enhancing the quality of green fodder, cowpea is also grown as mixture/inter crop with cereals based crops like corn, pearl millet and sorghum (2). Efforts to increase livestock productivity are constrained due to feed/fodder shortages which is mainly due to lack of availability of quality fodder seeds.

The difficulty in producing high seed yields in forages is due to the failure of seed setting. The real yield limiting factor in cowpea is inadequacy of source and sinks (3). The seed yield of cowpea could be enhanced through agronomic management practices and of course by the foliar application of bio-regulators. Now-a-days, bio-regulators are considered as new generation agrochemicals after fertilizers, pesticides and herbicides and can considerably affect the economic value and quality of crops. Application of bio-regulators on crops has been considered as suitable agro-technique for realizing higher crop yield and improving the economic status of the farmers by many workers in vegetable and fiber crops (4). Foliar applied bio-regulators have been found beneficial in improving growth, retention of more flowers on plant, improved fruit set and seed yield in many crops but efficacy is varied with different legume species and climatic conditions of the area (5). Moreover, no information is available on impact of bio-regulators on seed yield and their economics in forage cowpea and hence an investigation was undertaken to find out the effective and economical use of bio-regulator in forage cowpea cultivars under irrigated conditions of Punjab.

MATERIALS AND METHODS

Field experiment was carried out during summer seasons of 2008 and 2009 at the Fodder Farm of the Guru Angad Dev Veterinary and Animal Sciences University, Ludhiana (30°56' N, 75°52E'; 247 m above sea level) from August to November. The average annual rainfall is about 650 mm. The soil of the experimental field was sandy loam in texture having pH

Table-1: General cost of cultivation (Rs./ha) for seed production of forage cowpea cultivars.

Cultivars	Tractor hours cost for field preparation and sowing	Seed cost	Seed treatment cost	Fertilizer cost	Insecticide cost	Herbicide cost	Irrigation cost	Human labour cost	Transportation and marketing cost	Total variable cost	Interest on variable cost @ 9%	Total cost of cultivation
CL 367	1800	500	20	1497	150	760	80	6000	450	11257	507	11764
Cowpea 88	1800	1000	40	1497	150	760	80	6000	450	11777	530	12307

Assuming: Own land.

Cost of different variable inputs :

Tractor hours include discing, cultivator, sowing, planking and ridge making @ Rs. 225/hr,
Fungicide (Bavistin) cost @ Rs.500/kg,
Herbicide (Stomp) cost @ Rs.300/litre, Fertilizer cost of Urea@ Rs. 480/quintal,
Irrigation cost @ Rs. 20/irrigation,
Cost of sodium benzoate Rs. 600/kg,
Cost of salicylic acid Rs. 1000/kg,
Quantity of water used for spray 250 litres/ha

Seed cost @ Rs. 25/kg for CL 367 and Cowpea 88 cultivar
Insecticide (Malathion) cost @ Rs. 200/litre
Single Super Phosphate @ Rs. 400/quintal
Human labour cost @ Rs. 15/hr
Cost of calcium chloride Rs. 400/kg
Cost of KNO_3 Rs. 100/kg

7.2, with 0.25% carbon, 11.3 kg/ha P and 289 kg/ha K. The experiment was laid out in a factorial randomized complete block design with three replications. The treatments included combinations of two cultivars (CL 367 and Cowpea 88) of forage cowpea, and foliar application of 4 bio-regulators at different concentrations namely, sodium benzoate (100 and 150 µg/ml), salicylic acid (50 and 100 µg/ml), $CaCl_2$ (0.5 and 1.0%) and KNO_3 (1.0 and 2.0%). An additional untreated control was also included in the study. Cultivar Cowpea 88 exhibited flower initiation on September 18, whereas in cultivar CL 367 flowering started from September 24 during the year 2008. The corresponding dates for flower initiation in cultivar Cowpea 88 and CL 367 during the year 2009 were September 21 and September 26, respectively. Three foliar sprays of above said bio-regulators were applied at weekly interval starting from flower initiation in both the cultivars. The experimental crop was sown on August 7 and 8 during the year 2008 and 2009, respectively in lines keeping the row to row distance 30 cm in well prepared seed bed using 20 kg seed/ha for CL 367 and 40 kg seed/ha for Cowpea 88. Seeds of both the cultivars were treated with Bavistin (Carbendazim) at 2.0 g/kg of seed before sowing for protecting the crop from fungal diseases. A basal dose of 19 kg N/ha (42 kg/ha urea) and 56 kg P_2O_5/ha (350 kg/ha single super phosphate) were applied at sowing. Stomp (Pendimethalin) 30 EC at 2 litre/ha was applied immediately after sowing of the crop during both the year to control the weeds. Total of four irrigations were applied to the crop during the growing seasons. For controlling the aphid and jassid on the crop, 500 ml/ha of Malathion 50 EC was sprayed on September 14 during 2008 and September 19 during 2009, respectively. The seed crop was harvested from 15 m^2 net plot area on November 11, 2008 and November 13, 2009 when 80% of the pods turned yellow. The harvested crop was left in the field for one week so as to obtain the desired moisture level around 12% in seed for easy threshing and storage.

The expenditure incurred on tractor hours, irrigation, sprays, manuring, pesticides, bio-regulators in each treatment were worked out to obtain total cost (Table-1 and 2). However, the net profit was obtained after deducting the cost of cultivation from gross return. In order to find out benefit-cost ratio the net return from individual treatment was divided by their

Table-2: Cost of cultivation including cost treatment of various bio-regulators used in cowpea.

Bio-regulator treatments	Quantity of bio-regulator g/ha	Number of sprays	Total quantity of bio-regulator required g/ha	Cost of bio-regulator/ ha (Rs.)	Cost of labour for application of bio-regulator (Rs.)	Cost of cultivation including cost of treatment/ ha for CL 367 (Rs.)	Cost of cultivation including cost of treatment/ ha for Cowpea 88 (Rs.)
Control	0	0	0	0	0	11764	12307
Sodium benzoate at 100 µg/ml	25	3	75	45.0	720	12529	13072
Sodium benzoate at 150 µg/ml	45	3	135	81.0	720	12565	13108
Salicylic acid at 50 µg/ml	12.5	3	37.5	37.5	720	12522	13065
Salicylic acid at 100 µg/ml	25.0	3	75	75.0	720	12559	13102
$CaCl_2$ at 0.5%	1250	3	3750	1500.0	720	13984	14527
$CaCl_2$ at 1.0%	2500	3	7500	3000.0	720	15484	16027
KNO_3 at 1.0%	2500	3	7500	750.0	720	13234	13777
KNO_3 at 2.0%	5000	3	15000	1500.0	720	13984	14527

respective cost of cultivation which included cost of treatments also. The economics was calculated considering then prevailing prices of inputs and outputs. The modal selling rate of Rs. 2500/quintal for seed and Rs. 50/quintal for stover were taken as per then prevailing rates in the market. The experimental data were statistically analyzed using analysis of variance under factorial randomized block design.

RESULTS AND DISCUSSION

The data presented in Table-1 revealed that the cost of cultivation for cowpea cultivar CL 367 and C 88 was Rs. 11764/- and Rs. 12307/ha, respectively, which included variable costs such as tractor charges for various agronomic operations, seed cost, fertilizers costs, irrigation cost, labor cost, and plant protection practices costs. Treatment wise additional cost was comprised of different treatments of bio-regulators for both the cultivars (Table-2). Seed and stover yield of cowpea cultivars CL 367 and Cowpea 88 under different treatments is given in Table 3. Mean seed yield in cultivar CL 367 was 37.6 % higher than Cowpea 88, respectively. The observed differences among genotypes for yield parameters could be attributed to the intrinsic differences in the ability of different cultivars to access growth resources (6). Cultivar CL 367 recorded significantly higher gross return (Rs. 44771/ha), net return (Rs. 31591/ha) and benefit cost ratio (1:2.41) than Cowpea 88 cultivar due higher seed yield (Table 3).

Foliar application of different bio-regulators recorded significant effect on seed yield of cowpea. The

Table-3: Effect of different cultivars and bio-regulators on seed yield, stover yield, gross return, net return/ha and benefit-cost ratio (pooled)

Treatments	Seed yield (q/ha)	Stover yield (q/ha)	Gross return (Rs.)	Net return (Rs.)	Benefit cost ratio
Cultivars					
CL 367	16.1	88.4	44771	31591	2.41
Cowpea 88	11.7	87.6	33696	19973	1.46
LSD (P=0.05)	0.42	NS	1085.5	1085.5	0.08
Bio-regulators					
Control	11.6	71.5	32576	20540	1.71
Sodium benzoate at 100 µg/ml	13.1	83.4	36796	23995	1.88
Sodium benzoate at 150 µg/ml	13.8	86.5	38782	25945	2.03
Salicylic acid at 50 µg/ml	15.4	95.2	43281	30488	2.39
Salicylic acid at 100 µg/ml	14.3	91.6	40228	27397	2.14
$CaCl_2$ at 0.5%	14.0	90.1	39468	25212	1.77
$CaCl_2$ at 1.0%	14.7	91.4	41297	25541	1.63
KNO_3 at 1.0%	13.9	89.7	39133	25627	1.91
KNO_3 at 2.0%	14.8	92.5	41543	27888	1.93
LSD (P=0.05)	0.90	7.42	2303	2303	0.17

Modal selling rate of cowpea seed Rs. 2500/quintal   Selling rate for stover Rs. 50/quintal highest seed yield, gross return, net return and benefit-cost ratio was observed in salicylic acid at 50 μg/ml foliar treatment in both the cultivars. Data averaged over the year (Table-3) showed that foliar application of salicylic acid at 50 μg/ml recorded 33% increase in seed and stover yield over control and was statistically at par with other bio-regulators such as 1% $CaCl_2$ and 2% KNO_3. The increase in yield of cowpea by using bio-regulator salicylic acid might be due to enhanced assimilation, nutrient uptake, and more photosynthesis, improved flow assimilates and translocation from source to sink, increased cell integrity which in turn reflected on the increase in seed yield (5). The studies conducted by (7) also recorded similar results in chickpea with the application of 50 and 100 μg/ml of salicylic acid as foliar spray at vegetative (40 DAS) and reproductive stage (55 DAS). The increase in seed yield with the foliar treatments of $CaCl_2$ at 1% and KNO_3 at 2% was to the tune of 24.8% and 27.5%, respectively than control which might be due to availability of calcium and K ions to plants which play an important role in many biochemical processes (5). On the two years mean basis of net return, salicylic acid 50 μg/ml was most economical foliar spray and given significantly higher benefit cost ratio (1:2.39) than other treatments including control (Table-3). The higher returns from the seed crop of berseem were also recorded by Kumar and his associates (5) when 50 μg/ml salicylic acid was sprayed on crop at flower initiation. Similarly, Devi and co-workers (8) also recorded higher net returns in soybean crop, when different bioregulators were sprayed at flower (40 days after sowing) and pod initiation (60 DAS) stage of the crop. Although foliar application of 1% $CaCl_2$ and 2% KNO_3 has recorded at par seed yield with 50 μg/ml salicylic acid but due to escalated cost of chemicals (Table-2) the increase in seed yield was not found to be beneficial when net returns and benefit cost ratios were compared. Foliar applications of sodium benzoate exerted least effect on increase in seed yield in the study but recorded good returns than foliar application of $CaCl_2$ (0.5% and 1%) due to its lower cost. Application of salicylic acid at 100 μg/ml significantly reduced the seed yield, gross return, net return and benefit cost ratio as compared to salicylic acid at 50 μg/ml showing that higher concentration of salicylic acid has detrimental effect on the crop possibly due to its negative effect on photosynthetic efficiency of crop.

CONCLUSION

The cultivar CL 367 of cowpea recorded significantly higher seed yield, gross return, net return and benefit cost ratio than Cowpea 88 cultivar suggesting better cultivar for seed production. Different bio-regulators sprayed on cowpea during flower initiation had significant affect with respect to seed yield, stover yield, gross returns, net returns and benefit-cost ratios. Three foliar application of salicylic acid at 50 μg/ml stating from flower initiation at weekly interval had recorded highest gross return (Rs. 43281/ha), net return (Rs. 30488/ha) and benefit cost ratio (1:2.39) as compared to and all other foliar treatments including control.

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