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Effect of Polymercoat, Fungicides and Bioagent Treatment on Plant Growth, Seed Yield and Quality of Green Gram [*Vigna radiata* (L.) Wilczek]

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A B S T R A C T

The field experiment was conducted at Regional Agricultural Research Station, Vijayapur during *kharif*2019-20 to know the influence of polymer coat + fungicide + bioagent on field performance of green gram. The experiment was carried out in completely randomized block design with three replications and nine treatments consisting of different seed coatings including untreated control seeds. The results of the present investigation revealed that T_9 [Polymercoat @ 3 ml/kg of seeds + combi product of carbendazim 12% and mancozeb 63% (Saaf) @ 3 g/kg of seed + *Pseudomonas fluorescens* @ 30 g/kg seeds] was found to be significantly superior with respect to growth and seed yield parameters *viz*., field emergence (98.67 %), plant height (70.98), number of branches per plant (16.07), number of pods per plant (18.80), number of seeds per pod (12.60), seed yield per plant (6.43 g), seed yield per plot (0.601 kg) and seed yield per hectare (695 kg) followed by T_8 (Polymercoat @ 3 ml/kg of seeds + Vitavax Power @ 3 g/kg of seeds + *Pseudomonas fluorescens* @ 30 g/kg of seeds) against untreated control (T_1). The laboratory experiment was conducted in Department of Seed Science and Technology, College of Agriculture, Vijayapur to study on seed quality parameters *viz*., 100 seed weight (3.947 g), germination percentage (98.67 %), root length (18.18 cm), shoot length (16.9 cm), seedling vigour Index (3462), seedling dry weight (189.77 mg/10 seedlings) and electrical conductivity (0.787 dSm^{-1}) which were found to be higher in seeds obtained from T_9 followed by T_8 as compared to control (T_1) in green gram.

Introduction

Green gram [*Vigna radiata* (L.) Wilczek] is an important pulse crop belongs to the *Leguminosae* family and sub-family *Papilionaceae*. It is commonly referred to as mung bean, mung, moong or golden gram (John, 1991). It is one of the third most essential food legume grown in India next to pigeon pea and chickpea. Green gram output accounts for about 10-12 % of total pulse production in the country (Dolas *et al.*, 2018a).

In Karnataka, it occupies an area of 4.15 lakh hectares contributing to total production of 1.15 lakh tonnes and an average productivity of 277 kg/ha. It is widely grown in Gadag district which stands first position in area (70,316 hectares) and production (13,944 t) followed by Dharwad (26,350 ha and 8,432 t) and Bagalkote district with 51,675 ha and 4,883 tin area and production respectively (Sangamesh and Patil, 2018).

Green gram is one of India's most significant short-duration pulse crops with highly nutritious seeds that contain about 23.86% protein, 62.6% carbohydrates, 1.15% fat, 5.27% crude fibre, 3.32% ash besides rich in lysine (436 mg/g). It is also rich in minerals having 140 mg calcium, 8.4 per cent iron, 280 mg phosphorous and potassium which is a good reservoir of vitamins such as thiamine (0.621 mg), niacin (2.251 mg), ascorbic acid (4.8 mg), riboflavin (0.233 mg), pantothenic acid (1.910 mg), 114 IU vitamin A, vitamin B_1 (0.47 mg) and vitamin B_2 (0.39 mg) (Santhoshi *et al.*, 2017). The protein content of green gram is moderately high in lysine (436 mg/g), an amino acid that is low in methionine-rich cereal grains, cysteine and cystine, the amino acid-bearing sulphur. It has calorific value of 334 calories per 100 g of edible protein (Baldev *et al.*, 2003).

Seed treatment is a process of applying useful materials to form a continuous layer of thin coating over the seed without altering the shape or size, by employing water as the solvent. Currently seed coating polymers are being used by seed companies along with active ingredients such as fungicides and bioagents. This helps in improving the resistance of seeds towards pest and diseases in the much warranted juvenile stage, besides improves the seedling vigour (Vanangamudi *et al.*, 2003).

Seed treatment is also required in order to enclose the protective chemicals and nutrients applied to the seeds without substantial increase in the seed size or weight without the loss of chemicals that can be achieved by polymer coating. Polymer coating enables accurate and uniform dosage of chemicals and eliminates the chemical wastage. It provides protection against stress imposed by accelerated ageing, infection by fungi and pest infestation. It enhances emergence of seedlings and plant establishment in the field. Accurate application of chemicals eliminates the wastage and polymer coat helps to make room for including all required ingredients, nutrients, protectants, plant growth promoters, hydrophobic/hydrophilic substances, oxygen suppliers *etc*. to be used by enclosing the seed within a thin film of biodegradable polymer. When the seed treatment chemicals are adhered to the seed, it ensures dust free handling and makes treated seed both useful and environmentally safe. Polymer coating makes sowing operation simple and easier by causing the smooth flow of seeds. Addition of colorant to the seed helps in visual monitoring of accurate placement, enhance the appearance, marketability and consumer preference. The polymer film coat can serve as a physical barrier that has been noticed to reduce the leaching of inhibitors from the seed coverings and may limit oxygen diffusion to the embryo (Vanangamudi *et al.*, 2003).

Seed treatment with fungicide controls the external and internal seed borne pathogen and thereby acts as protective coating to prevent soil borne pathogens from seedling infections besides enhancing seed germination and seedling vigour of the host plants. Also the seed treatment with bioagents is safe, economical, eco-friendly, cheap, can be done easily with locally available materials and not harmful to seed, animals and human beings. The higher seed yield and better quality seed can be produced by treating the seeds with polymers, fungicides and bioagents.

Keeping these in view, the present investigation was carried out in green gram by seed treatment to determine the influence of polymer coating, fungicides and bioagents on seedling establishment, growth performance, seed yield, seed quality and productivity in field conditions.

Materials and Methods

The present investigation was conducted during *kharif*2019-20 in the research plots of Regional Agricultural Research Station, Vijayapur coming under Northern Dry Zone (Zone-3 and Region-II) of Karnataka and is situated at 16^0 49' N latitude, 75^0 43' E longitude and at an altitude of 593 mMSL. The soil of the experimental site was black clayey soil (vertisols), deep, porous in nature and well drained. The experiment consisted of nine treatment combinations was laid out in randomized block design with three replications. Seeds were sown with spacing of 30 cm between rows and 10 cm between plants. The plot size was 4.0 ×3.0 m.

The treatment combinations includedT_1- untreated control, T_2 - Polymercoat @ 3 ml/kg of seeds, T_3 - carbendazim @ 2 g/kg of seeds, T_4 - carboxin 37.5 % + thiram 37.5 % (Vitavax Power) @ 3 g/kg of seeds, T_5 - carbendazim 12 % + mancozeb 63 % (Saaf) @ 3 g/kg of seeds, T_6 - Polymercoat @ 3 ml/kg of seeds + VitavaxPower @ 3 g/kg of seeds, T_7 - Polymercoat @ 3 ml/kg of seeds + Saaf @ 3 g/kg of seeds, T_8 - Polymercoat @ 3 ml/kg of seeds + VitavaxPower @ 3 g/kg of seeds + *Pseudomonas fluorescens*@ 30 g/kg of seeds and T_9 - Polymercoat @ 3 ml/kg of seeds + Saaf @ 3 g/kg of seeds + *Pseudomonas fluorescens* @ 30 g/kg of seeds.

The liquid Disco AG Green L-202 polymer was used for seed coating, the polymer coat was manufactured by INCOTEC, the enhancement company, Ahmedabad and fungicides (carbendazim, Vitavax Power and Saaf) were collected from the local agro chemical dealers, Vijayapur. *Pseudomonas fluorescens* was collected from Department of Agricultural Microbiology, College of Agriculture, Vijayapur. One kg green gram seeds were taken in three separate polythene bags and 2 g of carbendazim, 3 g of Vitavax Power and 3 g of Saaf were added to those polythene bags separately. Then, 3 ml of polymer was added to the respective polythene bags as per the treatment. The polythene bags were closed tightly trapping the air in it to form a balloon, then the bags were shaken vigorously till the seeds were uniformly coated, later the treated seeds were spread on a polythene sheet to dry under the shade. At the time of sowing, these seeds were treated with 30g *Pseudomonas fluorescens* in the form of slurry, mixed to coat the seeds uniformly and spread on a polythene sheet to dry under the shade. The dried seeds were used for sowing. Cultural operations, application of fertilizer, method of sowing, plant protection, harvesting, threshing and cleaning was carried out as per the Package of Practices of University of Agricultural Sciences, Dharwad. Five plants were selected randomly and tagged in each treatment for recording plant growth and yield parameters. The research data was statistically analyzed for interpretation by adopting the procedures as described by Sundarrajan *et al.*, (1972).

Results and Discussion

The data on plant growth and yield parameters (Table 1) *viz*., field emergence, plant height, number of branches per plant, days to 50 % flowering, days to maturity number of pods per plant, number of seeds per pod, seed yield per plant, seed yield per plot and seed yield per hectare indicated that all the plant growth parameters differed significantly except days to 50 % flowering and days to maturity.

Table.1 Effect of polymer coating, fungicides and bioagents on plant growth and yield parameters of green gram

Treatments	Field emergence (%)	Plant height (cm)	Number of branches	Days to 50 % flowering	Days to maturity	Number of pods/ plant	Number of seeds/pod	Seed yield (g/plant)	Seed yield (kg/plot)	Seed yield (kg/ha)
T_1	90.67 (68.58)*	54.18	8.47	64.00	100.33	11.60	8.53	4.20	0.439	508
T_2	91.33 (72.88)	57.69	9.77	63.33	98.33	12.40	9.40	5.63	0.495	573
T_3	93.00 (74.66)	58.67	10.47	63.00	99.00	14.00	9.78	4.67	0.503	581
T_4	93.67 (75.42)	59.98	11.18	63.67	98.33	14.27	9.80	4.96	0.545	630
T_5	94.00 (75.82)	61.63	12.03	63.00	98.00	14.87	9.87	5.23	0.564	653
T_6	93.67 (75.42)	64.17	13.07	62.67	99.67	15.93	10.60	5.46	0.589	682
T_7	96.33 (78.96)	65.41	14.02	62.67	99.00	16.60	11.47	5.67	0.593	686
T_8	97.33 (80.60)	67.01	15.2	61.33	98.67	17.67	11.60	6.23	0.599	692
T_9	98.67 (83.37)	70.98	16.07	61.00	98.00	18.80	12.60	6.43	0.601	695
Mean	**94.30 (76.18)**	**62.19**	**12.25**	**62.74**	**98.81**	**15.13**	**10.4**	**5.39**	**0.549**	**633**
S.Em. ±	1.26	2.37	0.79	3.67	4.47	0.98	0.64	0.33	0.028	33
C.D. @ 5 %	3.77	7.16	2.38	NS	NS	2.94	1.91	1.01	0.085	99

NS: Non-significant *Figures in the parenthesis are square root transformed values

Seed Treatments (T)

T_1:Control (untreated)

T_2: Polymercoat @ 3 ml /kg of seeds

T_3: Carbendazim @ 2 g /kg of seeds

T_4: Carboxin 37.5 % + Thiram 37.5 % @ 3 g /kg of seeds (VitavaxPower)

T_5: Carbendazim 12% + Mancozeb 63% (Saaf) @ 3 g /kg of seeds

T_6: Polymercoat @ 3 ml /kg + VitavaxPower @ 3 g /kg of seeds

T_7: Polymercoat @ 3 ml /kg + Saaf @ 3 g /kg of seeds

T_8: Polymercoat @ 3 ml /kg + VitavaxPower @ 3 g /kg + *Pseudomonas fluorescen s*@ 30 g /kg of seeds

T_9: Polymercoat @ 3 ml /kg + Saaf @ 3 g /kg + *Pseudomonas fluorescens* @ 30 g /kg of seeds

Table.2 Effect of polymer coating, fungicides and bioagents on seed quality parameters of green gram

Treatments	Hundred seed weight (g)	Germination percentage (%)	Shoot length (cm)	Root length (cm)	Seedling vigour index	Seedling dry weight (mg)	Electrical conductivity (dSm^{-1})
T_1	3.346	91.67 (71.89)*	15.69	16.52	2952	178.14	0.880
T_2	3.548	93.33 (72.55)	15.90	16.75	3048	181.50	0.856
T_3	3.680	94.67 (75.05)	16.08	16.98	3132	183.67	0.853
T_4	3.722	94.33 (76.24)	16.25	17.25	3160	183.33	0.853
T_5	3.769	95.33 (76.87)	16.31	17.50	3223	184.33	0.865
T_6	3.765	96.33 (77.00)	16.56	17.68	3298	186.33	0.837
T_7	3.800	97.33 (80.64)	16.67	17.73	3348	187.67	0.810
T_8	3.862	98.33 (81.26)	16.83	18.03	3427	188.50	0.797
T_9	3.947	98.67 (82.67)	16.91	18.18	3462	189.77	0.787
Mean	**3.716**	**95.56 (77.13)**	**16.35**	17.40	**3228**	**184.8**	**0.838**
S.Em. ±	0.086	1.674	0.200	0.230	61.940	1.778	0.016
C.D. @ 1 %	0.255	4.975	0.599	0.685	185.44	5.283	0.048

Seed Treatments (T)

T_1:Control (untreated)

T_2: Polymercoat @ 3 ml /kg of seeds

T_3: Carbendazim @ 2 g /kg of seeds

T_4: Carboxin 37.5 % + Thiram 37.5 % @ 3 g /kg of seeds (VitavaxPower)

T_5: Carbendazim 12% + Mancozeb 63% (Saaf) @ 3 g /kg of seeds

T_6: Polymercoat @ 3 ml /kg + VitavaxPower @ 3 g /kg of seeds

T_7: Polymercoat @ 3 ml /kg + Saaf @ 3 g /kg of seeds

T_8: Polymercoat @ 3 ml /kg + VitavaxPower @ 3 g /kg + *Pseudomonas fluorescens*@ 30 g /kg of seeds

T_9: Polymercoat @ 3 ml /kg + Saaf @ 3 g /kg + *Pseudomonas fluorescens*@ 30 g /kg of seeds

The treatment with Polymercoat @ 3 ml/kg of seeds + Saaf @ 3 g/kg of seeds + *Pseudomonas fluorescens* @ 30 g/kg of seeds (T_9) recorded higher field emergence (98.67 %) followed by Polymercoat @ 3 ml/kg + Vitavax Power @ 3 g/kg + *P. fluorescens* @ 30 g/kg of seeds (97.33 %) while, untreated seeds recorded minimum field emergence (90.67 %). This might be due to suppression of the activity of soil borne pathogens or fungi by seed treatment and improved seed germination, vigour and field emergence which facilitated the emergence and establishment of healthy seedlings. Similar findings were confirmed earlier by Dubey *et al.,* (2011) in mung bean who noticed an increase in seed germination due to combined seed treatment of *Trichoderma virens* and carboxin in green gram under field conditions.

In the present study, significantly higher plant height (70.98 cm) and number of branches per plant (16.07) was observed in seeds treated with Polymercoat @ 3 ml/kg of seeds + Saaf @ 3 g/kg of seeds + *Pseudomonas fluorescens* @ 30 g/kg of seeds (T_9)followed by Polymercoat @ 3 ml/kg + VitavaxPower @ 3 g/kg + *P. fluorescens* @ 30 g/kg of seeds (67.01 cm and 15.20 respectively).This may be mainly due to efficient accumulation of photosynthates in the vegetative plant parts. These findings are in agreement with the results obtained by Chikkanna *et al.,* (2000) in cowpea and groundnut, Shakuntala (2010) in Sunflower, Vinodkumar *et al.,* (2013) and Anathi *et al.,* (2015) in redgram.

There was no significant difference between treatments with respect to days to 50 % flowering and days to maturity.

Significant difference among the seed treatments was observed with respect to yield attributes. Among the treatments, Polymercoat @ 3 ml/kg + Saaf @ 3 g/kg + *P. fluorescens* @ 30 g/kg of seeds recorded significantly highest number of pods per plant and seeds per pod (18.80 and 12.60) over untreated control (11.60 and 8.53).The increase in number of pods may be due to the more number of branches per plant, decreased flower drop, increased pod setting, nutrient mobilization, nutrient uptake, release of plant growth promoting substances by microbial inoculants and antagonistic activity against pathogens. Similar response due to seed treatment was observed by Tripathi and Singh (1991), Kanti *et al.,* (2013) and Narayanan *et al*., (2017) in blackgram.

Seed treatments gave significantly higher seed yield per plant and seed yield per plot over control (4.20 g and 0.439 kg). Polymer coating with Saaf + *P. fluorescens* (T_9) recorded the maximum seed yield per plant and per plot (6.43 g and 0.601 kg) followed by polymer coating with VitavaxPower + *P. fluorescens* (T_8) (6.23 g and 0.599 kg).The increase in per plant yield mass may be attributed to good plant growth and development of the seeds promoted by polymer coating, fungicide and bioagents. Plant growth promoting substances secreted by microorganism helped in various metabolic activities and reduction of pathogens and in the proliferation of benefical organisms in the rhizosphere which led to higher number of branches and number of pods per plant which in turn led to higher seed yield per plant. Similar findings due to seed treatments were observed by Kawale *et al.,* (1989), Tripathi and Singh (1991), Chikkanna *et al.,* (2000), Shakuntala *et al.,* (2010) and Vinodkumar *et al.,* (2013) and Kanti *et al.,* (2013).

There was a significant improvement in seed yield per hectare in the seed treatments with polymercoat @ 3 ml/kg + Saaf @ 3 g/kg + *P. fluorescens* @ 30 g/kg of seeds (695 kg) followed by Polymercoat @ 3 ml/kg of seeds + Vitavax power @ 3 g/kg of seeds +

Pseudomonas fluorescens@ 30 g/kg of seeds (T_8) (692 kg) as compared to untreated control (508 kg). The increased yield was attributed to better plant establishment with suppression of seed borne diseases. Similar studies were conducted by Narayanan *et al.,* (2017) in black gram who reported that seeds fortified with $MgSO_4$ + polykote + carbendazim + dimethoate + bioinoculant (*P. fluorescens*) + *Rhizobium* + Azophos + pelleting with DAP recorded higher seed yield and other parameters when compared to control. Similar findings were also observed by Rajeswari and Meena (2009) in soybean.

The probable reason for such findings was due to more number of pods per plant and seed yield per plant which in turn led to higher yield per hectare. Increase in yield may be attributed to extensive root development and better uptake translocation of nitrogen and phosphorous towards above ground parts. Similar results were also reported by Chikkanna *et al.,* (2000), Shakuntala *et al.,* (2010) and Vinodkumar *et al.,* (2013).

The data (Table 2) on seed quality parameters *viz*., 100 seed weight (g),germination (%),shoot length (cm), root length (cm), seedling vigour index, seedling dry weight (mg/10 seedlings)and electrical conductivity (dSm^{-1}). The treatment with Polymercoat @ 3 ml/kg of seeds + Saaf @ 3 g/kg of seeds + *Pseudomonas fluorescens* @ 30 g/kg of seeds (T_9) recorded highest 100 seed weight (3.947 g),seed germination (98.67 %),shoot length (16.91 cm), root length (18.18 cm), seedling dry weight (189.77 mg/10 seedlings), seedling vigour index (3462) and lowest electrical conductivity (0.787 dSm^{-1})and it was followed by Polymercoat @ 3 ml/kg of seeds + Vitavax power @ 3 g/kg of seeds + *Pseudomonas fluorescens* @ 30 g/kg of seeds (T_8) with 100 seed weight, germination, shoot length, root length, seedling dry weight, seedling vigour index and electrical conductivity of 3.862 g, 98.33 %, 16.83 cm, 18.03 cm, 3427 and 0.797 dSm^{-1}, respectively as compared to control (T_1).

These results are in agreement with the findings of Anathi *et al.,* (2015) in red gram reported that the seed hardening with 100 ppm $ZnSo_4$ and coating with polymer @ 3 ml kg^{-1} of seed that were added with bavistin @ 2 g kg^{-1} and imidacloprid @ 1ml kg^{-1} of seed along with *P. fluorescens*@ 10 g/kg and *Rhizobium*) recorded highest seed germination per cent than control. Similar trend was noticed with 100 seed weight (3.947 g), germination percentage (98.67), shoot length (16.91 cm), root length (18.18 cm), seedling dry weight of (189.77 mg) and less electrical conductivity (0.787 dSm^{-1}) as compared to untreated. Similar findings were also reported by Sujatha and Ambika (2016) in black gram, Ovalesha *et al.,* (2017) in cowpea and Dolas *et al.,* (2018a) in mung bean.

The increase in 100 seed weight in treated seeds may be due to the inhibition of activity of pathogen resulted in more dry matter production and availability of photosynthates for sink which ultimately resulted in more seed weight. Similar findings were observed by Tripathi and Singh (1991), Anuja and Aneja (2000), Taywede *et al.,* (2002) and Rezende *et al.,* (2003) in soybean. Desai *et al.,* (1997) reported that high frazzle increases the membrane damage, disturbance of certain enzyme activity responsible for degradation of macromolecules into micro molecules within the seed and other cell structures and thus higher electrical conductivity in untreated seeds.

From the results of this investigation, it can be concluded that seeds treated withPolymercoat @ 3 ml/kg of seeds + Saaf @ 3 g/kg of seeds + *Pseudomonas fluorescens* @ 30 g/kg of seeds could be advocated for better field performance and seed quality parameters, so as to get higher seed yield with good quality seeds.

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