Research Article
Published: 07 Sep, 2020

SF Plant Science and Seed Research

Effect of Super Absorbent Polymercoating on Seed Yield and Quality of Green Gram (*Vigna radiata* L.) Under Field Condition

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Abstract

A field experiment was carried out with green gram cv. CO 8 to study the impact of different Super Absorbent Polymer (SAP) coating on growth, yield and seed quality. The optimized concentration of different SAPs *viz.*, Sodium Polyacrylate (SPA), Polyacrylamide (PA) and Coir pith based SAP@7, 2 and 8 g/kg of seeds respectively were applied along with $MnSO_4$@100 ppm to green gram seeds and uncoated seeds (control) served as control. The growth parameters *viz.*, field emergence, plant height, Leaf Area Index (LAI), Chlorophyll 'a','b' and total chlorophyll content, phonological parameters *viz.*, days to first flowering and 50% flowering, yield parameters *viz.*, no. of cluster per plant, no. pods per plant, pod length, no of seeds per pod, pod yield per plant, pod yield per plot, seed yield per plant, seed yield per plot and seed yield per hectare and resultant quality parameters *viz.*, germination and seedling vigour were recorded and found to be statistically significant from other treatments. However, the speed of germination, seedling length, dry matter production and α-amylase content registered non-significant results. Generally, SAPs coating on green gram seeds exhibited superior performance in all the growth and yield parameters when compared with control. Among the tested SAPs, coir pith based SAP was eco-friendly and biodegradable that expressed better performance for all the tested parameters.

Keywords: Green gram; Super absorbent polymers coating; Enhanced growth; Seed yield and quality

Introduction

Green gram (*Vigna radiata* L.) being a major pulse crop grown in India contribute more towards food production. It belongs to Fabaceae and Papilionaceae family and sub-family respectively. It is the most amendable crop cultivated throughout the year. It is a short duration, self-pollinated crop native of South-East Asia (India-Burma region) and are widely cultivated all over Asia. It is one among the thirteen food legumes cultivated in India. However, due to failure of monsoon, crop is witnessing water famines and resulting in below-average crop income.

One of the novel and innovative method to pace worthwhile seed production is the use of Super Absorbent Polymers (SAPs) as a seed coating material. SAPs are hydrophilic polymers and are lightly cross-linked in a three dimensional network which facilitate the absorption of water and swell to several times than their original dimensions thereby increases in weight [1]. SAPs will retain the water by capillary forces and supply the plants by osmosis. SAPs are classified into two categories as synthetic and natural. Most of the commercially available SAPs viz., Sodium Polyacrylate, Polyacrylamide, etc., are synthetic based materials which possess deleterious effect on the quality of the soil by staying in the soil for a long period of time due to non-biodegradable nature. To concern the environmental pollution, naturally synthesized SAP which are harmless, non-hazardous, biocompatible, recyclable and eco-friendly are used in place of synthetic polymers and also it supplies nutrients to the seedlings [2]. Generally, seed coating with SAPs requires less quantity, besides it improves the per cent of seed germination, mean germination time and promote seedling growth in the early developmental stages of plant and eventually results in enhanced seed yield [3]. SAP coated seed enhances the water retention capacity of the soil present in the micro-environment of seed and protects the crop from permanent wilting point under extreme evaporation, thus reducing the irrigation requirements.

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***Received Date:** 21 Jul 2020*
***Accepted Date:** 03 Sep 2020*
***Published Date:** 07 Sep 2020*
***Citation:** Suganya K, Jerlin R, Raja K. Effect of Super Absorbent Polymercoating on Seed Yield and Quality of Green Gram (Vigna radiata L.) Under Field Condition. SF Plant Sci Seed Res. 2020; 1(1): 1002.*

Materials and Methods

The cleaned and graded seeds of green gram cv.Co 8 were coated with various SAPs (Sodium polyacrylate (SPA), Polyacrylamide (PA) and coir pith based SAP) of optimized concentration of SPA (7 g/kg of seeds), PA (2 g/kg of seeds) and Coir pith based SAP (8 g/kg of seeds) along with $MnSO_4$@100 ppm and uncoated seeds (control) which were assigned as treatments for this study. The field trial was carried out in Randomized Block design (RBD) with four replications. Different parameters *viz*., field emergence, plant height, Leaf Area Index (LAI), Chlorophyll 'a','b' and total chlorophyll content by acetone method, days to first flowering, 50% flowering, no. of cluster per plant, no. pods per plant, pod length, no of seeds per pod, pod yield per plant, pod yield per plot, seed yield per plant, seed yield per plot and seed yield per hectare were observed. Resultant seed quality parameters *viz*., speed of germination, germination, seedling length, dry matter production, seedling vigour and α-amylase content by Paul et al., 1970 method were also recorded.

The data acquired from this experiment were analyzed by employing statistical analysis [4]. At 5% probability level, the Critical Difference (CD) was calculated. The data observed in percentage and count data were analysed using arcsine and square root transformation. If F-test was specified as NS, it represented non-significant values.

Result and Discussion

Growth parameters *viz*., field emergence, plant height, Leaf Area Index (LAI), Chlorophyll 'a','b' and total chlorophyll content, phonological parameters *viz*., days to first flowering and 50% flowering, yield parameters *viz*., no. of cluster per plant, no. pods per plant, pod length, no of seeds per pod, pod yield per plant, pod yield per plot, seed yield per plant, seed yield per plot and seed yield per hectare and resultant quality parameters *viz*., germination and seedling vigour were found be statistically significant from other treatments.

The highest field emergence was observed in coir pith based SAP@8 g/kg of seeds (87%) (Table 1). The coir pith based SAP absorbed the surrounding soil water and resulted in increased number of germinated seeds by retaining the absorbed water on the surface of seeds [3]. However, SPA and PA coatings also enhanced the seedling emergence but not up to the level of coir pith based SAP. Further, control (82%) recorded the lowest field emergence. Plant height being genetically controlled trait, it can also be attributed by surrounding conditions. In this study, coir pith based SAP@8 g/kg of seeds recorded the maximum plant height at 15 DAS (14.9 cm), 30 DAS (22.7 cm), 45 DAS (33.6 cm) and 60 DAS (35.6 cm) (Table 1). The maximum plant height at all duration intervals may be associated with water supplied by coir pith based SAP and in turn these have been stated to surge in cell differentiation (cell elongation and division). These findings are in accordance with Sanliang (1996) [5] in tomato and Sivapalan (2001) [6] in soybean.

Assessing the Leaf Area Index (LAI) provides the photosynthetic ability of plants and reduced leaf area indicates that plant is ready to response drought conditions. The outcome of the study discloses that LAI was more in coir pith based SAP@8 g/kg of seeds at 15 DAS (0.075), 30 DAS (0.151), 45 DAS (0.191) and 60 DAS (0.190) than other treatments. This is because of the nature of coir pith based SAP to absorb the water and supply at appropriate time to the growing plants (Table 2). As the water present in the plant cell decreases, cell shrinks and results with low turgor pressure. Coir pith based SAP due to its nature absorbs and holds more water and in turn hikes the cell turgor pressure and maintains the required volume of water needed for plant and eventually results in hike of leaf area [7]. The outcome is in accordance with Malekian et al. (2012) [8] in maize. Chlorophyll plays a pivotal role in harvesting sun's energy and converting them into biochemical energy, which is an important one for photosynthesis. Hike in chlorophyll 'a','b' and total chlorophyll in coir pith based SAP@8 g/kg of seeds at 15 DAS (0.563, 0.364 and 0.927 mg/g), 30 DAS (0.676, 0.457 and1.133 mg/g), 45 DAS (0.854, 0.541 and 1.395 mg/g) and 60 DAS (0.764, 0.481 and 1.245 mg/g) were registered. An increased 5 per cent of total chlorophyll was noticed at 45 DAS (Table 3). The decrease in chlorophyll 'a','b' and total in other treatments might be attributed to reduced chlorophyll biosynthesis

Table 1: Effect of different SAP coating treatments on field emergence (%) and plant height (cm) at different crop growth stages of green gram cv. CO 8.

Treatments	Field emergence (%)	Plant height (cm)			
		15 DAS	30 DAS	45 DAS	60 DAS
T_1	82(64.89)	12.5	20.8	31.4	33.3
T_2	83 (65.65)	12.6	20.9	31.6	33.5
T_3	84 (66.42)	12.9	21.1	32.1	34.1
T_4	84 (67.22)	13.1	21.4	32.9	34.4
T_5	87 (68.87)	14.9	22.7	33.6	35.6
Mean	84 (66.42)	13.2	21.4	32.3	34.2
SEd	0.5	0.19	0.29	0.36	0.48
CD (*P*=0.05)	1.0	0.41	0.63	0.78	1.04

(Figures in parenthesis indicate arcsine transformed values); T_1-Control; T_2 -$MnSO_4$@100 ppm; T_3-SPA@7 g/kg of seeds; T_4-PA@2 g/kg of seeds; T_5-Coir pith based SAP@8 g/kg of seeds

Table 2: Influence of various SAP coating treatments on leaf area index at different crop growth stages of green gram cv. CO 8.

Treatments	15 DAS	30 DAS	45 DAS	60 DAS
T_1	0.045	0.129	0.166	0.164
T_2	0.055	0.134	0.171	0.169
T_3	0.057	0.140	0.179	0.177
T_4	0.069	0.146	0.184	0.183
T_5	0.075	0.151	0.191	0.190
Mean	0.060	0.140	0.180	0.177
SEd	0.0045	0.0005	0.0023	0.0004
CD (*P*=0.05)	0.0097	0.0011	0.0051	0.0010

T_1-Control; T_2 -$MnSO_4$@100 ppm; T_3-SPA@7 g/kg of seeds; T_4-PA@2 g/kg of seeds; T_5-Coir pith based SAP@8 g/kg of seeds

Table 3: Influence of different SAP seed coating treatments on Chlorophyll "a" (mg/g) at different crop growth stages of green gram cv. CO 8.

Treatments	15 DAS	30 DAS	45 DAS	60 DAS
T_1	0.528	0.645	0.824	0.720
T_2	0.535	0.652	0.832	0.727
T_3	0.543	0.659	0.841	0.736
T_4	0.557	0.667	0.849	0.759
T_5	0.563	0.676	0.854	0.764
Mean	0.545	0.660	0.840	0.741
SEd	0.0004	0.0004	0.0003	0.0004
CD (*P*=0.05)	0.0010	0.0009	0.0007	0.0009

T_1-Control; T_2 -$MnSO_4$@100 ppm; T_3-SPA@7 g/kg of seeds; T_4-PA@2 g/kg of seeds; T_5-Coir pith based SAP@8 g/kg of seeds

Table 4: Influence of different SAP coating treatments on Chlorophyll "b" (mg/g) at different crop growth stages of green gram cv. CO 8.

Treatments	15 DAS	30 DAS	45 DAS	60 DAS
T_1	0.344	0.426	0.515	0.459
T_2	0.348	0.434	0.521	0.468
T_3	0.352	0.437	0.528	0.471
T_4	0.359	0.445	0.535	0.477
T_5	0.364	0.457	0.541	0.481
Mean	0.353	0.440	0.528	0.471
SEd	0.0002	0.0003	0.0004	0.0005
CD (*P*=0.05)	0.0003	0.0006	0.0010	0.0010

T_1-Control; T_2 -$MnSO_4$@100 ppm; T_3-SPA@7 g/kg of seeds; T_4-PA@2 g/kg of seeds; T_5-Coir pith based SAP@8 g/kg of seeds

Table 5: Influence of different SAP coating treatments on total chlorophyll (mg/g) at different crop growth stages of green gram cv. CO 8.

Treatments	15 DAS	30 DAS	45 DAS	60 DAS
T_1	0.872	1.071	1.339	1.179
T_2	0.883	1.086	1.353	1.195
T_3	0.895	1.096	1.369	1.207
T_4	0.916	1.112	1.384	1.236
T_5	0.927	1.133	1.395	1.245
Mean	0.899	1.100	1.368	1.212
SEd	0.0011	0.0014	0.0023	0.0019
CD (*P*=0.05)	0.0025	0.0035	0.0054	0.0042

T_1-Control; T_2 -$MnSO_4$@100 ppm; T_3-SPA@7 g/kg of seeds; T_4-PA@2 g/kg of seeds; T_5-Coir pith based SAP@8 g/kg of seeds

Table 6: Effect of different SAP coating treatments on phenological characters of green gram cv. CO 8.

Treatments	Days for first flowering	Days for 50% flowering
T_1	44	50
T_2	44	51
T_3	45	51
T_4	45	51
T_5	46	52
Mean	45	51
SEd	0.3	0.5
CD (*P*=0.05)	0.6	1.0

T_1-Control; T_2 -$MnSO_4$@100 ppm; T_3-SPA@7 g/kg of seeds; T_4-PA@2 g/kg of seeds; T_5-Coir pith based SAP@8 g/kg of seeds

by reason of insufficient volume of soil water to the growing plants. The outcome is in accordance with Sayyari and Ghanbari (2012) [9] in sweet pepper and Chaithra and Sridhara (2018) [10] in maize.

Phenological traits *viz*., days taken for first flowering and 50% flowering in coir pith based SAP@8 g/kg of seeds were delayed by two days compared to control plants. This may be due to timely supply of sufficient water by coir pith based SAP to plants whereas untreated plants (control) recorded earliness in first flowering and 50% flowering. This may be due to insufficient water supply to growing plants (Table 4). Subsequently, the life cycle has been hastened at a faster rate.

Yield is a multifaceted trait involving the interaction of many internal and extrinsic factors. In addition to surrounding environmental factors in which the plant is exposed while growing, the plant mainly depends on synthesis and utilisation of carbohydrates, water and nutrients from the growing soil [11]. An increase in no. of cluster per plant (28%), no. pods per plant (14%), pod length (3%), no of seeds per pod (25%), pod yield *viz*., pod yield per plant (9%), pod yield per plot (15%) and seed yield *viz*., seed yield per plant (9%), seed yield per plot (14%) and seed yield per hectare (15%) might be associated with timely supply of water and nutrients by coir pith based SAP than other SAP coating treatments. This further leads to movement of photo assimilates and nutrients and eventually resulted in superior plant development with yield. The outcome of the dissertation are in line with Tripathi et al. (1997) [12] in Indian mustard, Amiri et al. (2013) [13] in soybean and in safflower (Table 5, 6, 7 and 8). Evaluation of resultant seed quality characters found to be significant in germination and vigour index which in turn increased by 8% and 10% respectively than other SAP coating treatments. However, speed of germination, seedling length, dry matter production and α-amylase content were found to be non-significant (Table 9).

Conclusion

The study clearly indicated that application of various SAPs as seed coating to green gram (SPA, PA and coir pith based SAP) aided in enhanced seed yield and quality parameters under field condition. Amidst various SAPs, coir pith based SAP being eco-friendly and biodegradable expressed better performance in all the parameters comparatively than other treatments. This is a pioneer study to progress novel technology to enhance seed quality which may directly benefit the growth of green gram particularly under rain fed condition where ensured germination and plant population are the key concern to increase production and productivity.

Table 7: Effect of different SAP coating on pod characteristics of green gram cv. CO 8.

Treatments	No. of clusters per plant	No. of pods per plant	Pod length (cm)	Pod yield per plant (g)	Pod yield per plot (kg)
T_1	7 (2.74)	28 (5.33)	6.6	7.21	1.89
T_2	7 (2.74)	29 (5.39)	6.7	7.45	1.95
T_3	8 (2.82)	28 (5.33)	6.6	7.56	1.99
T_4	8 (2.82)	30 (5.48)	6.8	7.69	2.08
T_5	9 (3.08)	32 (5.66)	6.8	7.88	2.18
Mean	8 (2.82)	29 (5.39)	6.7	7.56	2.02
SEd	0.10	0.06	0.7	0.004	0.004
CD (*P*=0.05)	0.21	0.12	0.1	0.008	0.009

T_1-Control; T_2 -$MnSO_4$@100 ppm; T_3-SPA@7 g/kg of seeds; T_4-PA@2 g/kg of seeds; T_5-Coir pith based SAP@8 g/kg of seeds

Table 8: Effect of different SAP coating treatments on seed characteristics of green gram cv. CO 8.

Treatments	No. of seeds/pod	100 seed weight (g)	Seed yield per plant (g)	Seed yield per plot(kg)	Seed yield per hectare (kg)
T_1	8 (2.92)	3.720	3.05	0.63	700
T_2	9 (3.08)	3.774	3.16	0.65	722
T_3	9 (3.08)	3.854	3.21	0.66	737
T_4	9 (3.08)	3.888	3.29	0.69	770
T_5	10 (3.24)	3.895	3.32	0.72	807
Mean	9 (3.08)	3.826	3.21	0.67	747
SEd	0.05	0.0004	0.004	0.005	0.5
CD (*P*=0.05)	0.12	0.0009	0.009	0.010	1.0

(Figures in parenthesis indicate square root transformed values); T_1-Control; T_2-$MnSO_4$@100 ppm; T_3-SPA@7 g/kg of seeds; T_4-PA@2 g/kg of seeds; T_5-Coir pith based SAP@8 g/kg of seeds

Table 9: Effect of different SAP coating treatments on physiological and biochemical seed quality of green gram cv. CO 8 seeds.

<table>
<tr><th>Treatments</th><th>Speed of germination</th><th>Germination (%)</th><th>Root Length (cm)</th><th>Shoot Length (cm)</th><th>Dry matter Production (g/10 seedling)</th><th>Vigour Index</th><th>α-amylase content (mg of maltose min^{-1})</th></tr>
<tr><td>T_1</td><td>6.9</td><td>83 (65.65)</td><td>16.8</td><td>15.1</td><td>0.219</td><td>2648</td><td>0.62</td></tr>
<tr><td>T_2</td><td>6.9</td><td>85 (67.22)</td><td>16.9</td><td>15.0</td><td>0.219</td><td>2727</td><td>0.62</td></tr>
<tr><td>T_3</td><td>7.0</td><td>85 (67.22)</td><td>16.9</td><td>15.1</td><td>0.220</td><td>2718</td><td>0.62</td></tr>
<tr><td>T_4</td><td>7.0</td><td>87 (68.87)</td><td>17.0</td><td>15.2</td><td>0.220</td><td>2831</td><td>0.63</td></tr>
<tr><td>T_5</td><td>7.0</td><td>90 (71.57)</td><td>17.0</td><td>15.2</td><td>0.220</td><td>2922</td><td>0.63</td></tr>
<tr><td>Mean</td><td>7.0</td><td>86 (68.03)</td><td>16.9</td><td>15.1</td><td>0.220</td><td>2769</td><td>0.62</td></tr>
<tr><td>SEd</td><td rowspan="2">NS</td><td>0.4</td><td rowspan="2" colspan="3">NS</td><td>56.1</td><td rowspan="2">NS</td></tr>
<tr><td>CD(P=0.05)</td><td>0.9</td><td>123.5</td></tr>
</table>

(Figures in parenthesis indicate arcsine transformed values); T_1-Control; T_2-$MnSO_4$@100 ppm; T_3-SPA@7 g/kg of seeds; T_4-PA@2 g/kg of seeds; T_5-Coir pith based SAP@8 g/kg of seeds

References

1. Talaat HA, Sorour MH, Aboulnour AG, Shaalan HF, Ahmed EM, Awad AM, et al. Development of a multi-component fertilizing hydrogel with relevant techno-economic indicators. J Agric Environ Sci. 2008; 3: 764-770.
2. Prajapati VD, Maheriya PM, Jani GK, Solanki HK. Carrageenan: A natural seaweed polysaccharide and its applications. Carbohyd Polym. 2014; 105: 97-112.
3. Akelah A. Functionalized Polymeric Materials in Agriculture and the Food Industry. Food Sci Nutr. 2013.
4. Panse VG, Sukhatme PV. Statistical methods for agricultural workers. Indian Council for Agricultural Research Publication. 1954.
5. Sanliang G, Fuchigami LH, Guak S, Shin C. Effect of short-term water stress, hydrophilic polymer amendment and antitranspirant on stomatal status, transpiration, water loss and growth in 'Better Boy'tomato plants. Journal of the American Society for Horticultural Science. 1996; 121: 831-837.
6. Sivapalan S. Effect of a polymer on growth and yield of soybeans (Glycine max) grown in a coarse textured soil. 2001.
7. Al-Harbi AR, Alomran AM, Choudhary MI, Wahdan H, Mursi M. Influence of soil conditioner rate on seed germination and growth of cucumber plants (Cucumis sativus L.). Arab Gulf Journal of Scientific Research. 2012; 14: 129-142.
8. Malekian A, Valizadeh E, Dastoori M, Samadi S, Bayat V. Soil water retention and maize (Zea mays L.) growth as effected by different amounts of pumice. Australian Journal of Crop Science. 2012; 6: 450.
9. Sayyari M, Ghanbari F. Effects of super absorbent polymer A200 on the growth, yield and some physiological responses in sweet pepper (Capsicum annuum L.) under various irrigation regimes. International Journal of Agricultural and Food Research. 2012; 1: 1-11.
10. Chaithra GM, Sridhara S. Yield and physiological parameters of maize as influenced by the application of super absorbent polymer and mulching under rainfed conditions. International Journal of Current Microbiology and Applied Sciences. 2018; 7: 216-224.
11. Schaffer B, Anderson PC. Subtropical and tropical crops. In: Handbook of environmental physiology of fruit crops. 1994.
12. Tripathi ML, Kurmvanshi SM, Namdeo KN. Effect of starch polymer and N-triacontanol on growth and yield of Indian mustard (Brassica juncea). Indian Journal of Agronomy. 1997; 42: 194.
13. Amiri AT, Sharifan H, Hesam M, Siavoshi M. Effect of super-absorbent treatment on soybean yield. Trends in Life Sciences. 2013; 2: 32-35.