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Influence of TSP polymer coating and biostimulants on seed germination behavior and seedling vigour of black gram var. VBN 8

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Abstract
This research was conducted to determine the effects of TSP polymer and with different biostimulants at various concentrations (such as panchagavya - 0.3, 0.6, 1.2 ml, vermiwash - 0.3, 0.6, 1.2 ml and humic acid – 0.12, 0.3, 0.6 g per 6g of polymer) on seed germination and seedling growth of black gram during 2021, under laboratory condition at department of seed science and technology, Tamil Nadu Agricultural University. The seeds of black gram var. VBN 8 were treated with TSP polymer (6g/kg of seeds), TSP polymer (6g) + panchagavya (0.3 or 0.6 or 1.2 ml), TSP polymer (6g) + vermiwash (0.3 or 0.6 or 1.2 ml) and TSP polymer (6g) + humic acid (0.12 or 0.3 or 0.6 g). Untreated seeds were served as control. The results showed non-significant difference for 1000 seed weight and seed moisture content. Seeds coated with TSP polymer + 0.3 g humic acid significantly increased the seed germination (90%) and seedling growth parameters compared to other treatments. It significantly reduced the abnormal seedling (4%) and dead seed (6%) percentage, besides it favours the uniform germination. The results concluded that black gram seeds (one kg) coated with TSP polymer (6g) + 0.3g humic acid performed better seedling establishment and could be recommended as pre sowing seed treatment.

Keywords: Black gram, TSP polymer, bio stimulant, humic acid, germination, vigour, seedling growth

Introduction

The purpose of any seed treatment is to improve seed performance in one or more of the following ways: 1) Improve germination rates and seedling vigour, 2). Optimize ease of handling and accuracy of planting (reduce gaps in stand or the need for thinning of seedlings, particularly when mechanical planters are used) and 3) Eradicate and protect the seed and seedlings from destructive pest and diseases. In conventional production, seed is often treated with chemical promoters, fungicides and insecticides which promotes the seed germination and seedling growth and protect the seed and seedlings from pest and diseases. Most of the seed promoters and protectants are not an option for organic growers; however, there are some seed treatments, such as priming, pelletizing and coating with bio stimulant and biopolymer that can be used by organic farmers to improve seed performance.

Our central goal is to develop plant based seed coating polymer that is compatible and beneficial to seeds. The polymer will be developed for seed coating with desired characteristics. These coating will also act as delivery systems for organic seed treatments. Specific objectives are to: 1) Develop seed coating polymer and 2) Selection of suitable Bio stimulant to be applied with the seed coating polymer.

Most of the available seed coating polymers are synthetic in nature and very slow degradable, toxic, and also it contain synthetic colorant, making it unsuitable for organic agriculture. Recently natural or plant based polymers of high molecular weight have drawn much attention because of their various practical applications. Polysaccharide based superabsorbent polymers have emerged as promising substitute; they are nontoxic biopolymer, abundant in nature, usually available at low cost and intrinsically biodegradable and biocompatible (Kamath and Park, 1993) [21].

Tamarind kernel powder (TKP) is derived from the seeds of the tree *Tamarindus indica*. It is found to be extensively used as a sizing material in the textile industry as well as in the food industry. It can also be used as an adhesive in bookbinding, cardboard manufacture and plywood industry and in sizing and weighting compositions in the leather industry (Prabhanjan and Ali, 1995) [37]. The sizing properties of TKP are due to the presence of a polysaccharide (called jellose).

Use of white TKP in three food products, jelly, fortified bread and biscuit has also been also detailed (Bhattacharya *et al.,* 1994 and Bhattacharya *et al.,* 1997) [5, 6]. Hence tamarind seed polysaccharide (TSP) can be effectively used for development of biopolymer (TSP polymer) for seed coating and ensure the organic seed treatment.

A biostimulant may be any substance or mixture of substances of natural origin or microorganism which improves the condition of crops without causing adverse effects (Du Jardin, 2015). Enzymes, proteins, amino acids, micronutrients and other compounds may be used as biostimulants. Natural stimulants are often included under the term biostimulants, including phenols, salicylic acid, humic acid, fulvic acid, vermiwash and protein hydrolases (Du Jardin, 2015 and Chiaiese *et al.,* 2018) [14, 10]. Biostimulants are substances that are prepared from natural raw materials (eg. Panchagavya).

Humic acid is a principal component of humic substances, which are the major organic constituents of humus, peat and coal. It is produced by biodegradation of dead organic matter. (Akinci *et al.,* 2009; Canellas *et al.,* 2002) [2, 8]. Humic acid (HA), characterized as a heterogeneous natural resource, ranging in colour from yellow to black and having high molecular weight. Humic acid, as a commercial product contains 44-58% C, 42-46% O, 6-8% H and 0.5-4% N, as well as many other elements (Larcher, 2003; Lee and Bartlett, 1976) [26, 27]. It improves soil fertility and increases the availability of nutrient elements by holding them on mineral surfaces. The humic substances are mostly used to remove or decrease the negative effects of chemical fertilizers from the soil and have a major effect on plant growth, as shown by many scientists (Ghabbour and Davies, 2001) [17]. The auxin like activity of these humic substances in plants influences the cell division and cell elongation (Mato *et al.,* 1971; Schnitzer and Weightman, 1974) [33, 41].

Vermiwash is liquid manure that has been reported to have excellent growth promoting effect besides serving as biopesticide. Vermiwash is the watery extract of vermicompost, extracted in the presence of rich population of earthworms and contains several enzyme, plant growth hormones, vitamins along with micro and macronutrients which increases the resistance power of crops against various diseases and enhance the growth and productivity of crops (Zambare *et al.,* 2008) [51].

Panchagavya means "mixture of five products (cow dung, cow urine, milk, ghee and curd) of cow". Of these, the three direct constituents are cow dung, cow urine and milk and the two derived products are curd and ghee. It has been used in traditional India rituals throughout history. Panchahavya is also used as fertilizer in agricultural operations. It is an organic product recommended for crop improvement in organic agriculture (Sangeetha and Thevanathan, 2010) [40]. It is used as a foliar spray, soil application along with irrigation, as well as seed treatment (Natarajan, 2002) [36]. Panchagavya has resulted in positive effect on growth and productivity of crops as reported by Somasundaram *et al.* (2007) [44].

Therefore, this study was carried out with an objective to evaluate the effect of TSP polymer from tamarind seed polysaccharides (TSP) and along with different biostimulant on seed germination and vigour of black gram.

Materials and Methods

The laboratory experiment was conducted at the Department of Seed Science and Technology, Tamil Nadu Agricultural University, Coimbatore, Tamil Nadu, India. The black gram seed var. VBN 8 was purchased from KVK Tindivanam, Villupuram, Tamil Nadu. Tamarind seeds were procured from tamarind market during April to May in Coimbatore, Tamil Nadu. Panchagavya and vemiwash were bought from Tamil Nadu Agricultural University, Coimbatore, Tamil Nadu. Humic acid were purchased from Sigma-Aldrich Chemical Co., Bangalore, India.

Design of the experiment

The laboratory experiment was conducted in the completely randomized block design with three replications.

Preparation of seed coating TSP polymer

TSP polymer was prepared from defatted tamarind kernel powder as per the process described by Kannan and Manavalan (2007) [22] with some modifications. Tamarind kernel powder defatted by mixing with benzene-ethanol solution (1:1 ratio v/v) at 1:2 ratio w/v and kept for 24 hours and then centrifuged at 10000 rpm for 30 minutes and the supernatants were discarded and the residue was dried in the oven at 40 ºC. 20g of the defatted tamarind seed kernel powder was mixed with 200 ml of 0.01M hydrochloric acid to and made into a and then the slurry was dispersed in 300 ml of boiling 0.01M hydrochloric acid and boiled for 30 minutes at 90 ºC in water bath. The slurry was cooled to room temperature, centrifuged at 4000 rpm for 10 minutes and the clear supernatant liquid was collected. From the supernatant, the polysaccharide was precipitated by the addition of equal volume of ethanol. The precipitate was separated by filtration through muslin cloth and dried in hot air oven at 50 ºC. Dried polysaccharide flakes were powdered with the blender and sieved through 125 µm mesh sieve (Sieve number 120) and stored in airtight containers at room temperature for further study.

To prepare polymer, 10 g of Tamarind Seed Polysaccharide (TSP) and one ml of glycerol were dissolved in 200 ml of water by stirring with a mechanical stirrer at 2000 rpm. After complete dissolution of the polysaccharide 4 g of agar dissolved with the solution and heated to about 90°C in water bath for 15 minutes. The solution was cooled at room temperature and stored in refrigerator.

Seed treatment

Polymer dose for black gram seed was fixed as 6 g/kg (6 g of polymer mixed with 15 ml of distilled water to coat one kg of seeds) based on preliminary study. Along with TSP polymer different concentration of various biostimulants were mixed and coated on seed. Treated seeds were shade dried for one hour and evaluated for various seed quality parameters. The treatment details were as follows,

T_0 – Control
T_1 – TSP polymer (6 g/kg)
T_2 – TSP polymer (6 g) + 0.3 ml of panchagavya
T_3 – TSP polymer (6 g) + 0.6 ml of panchagavya
T_4 – TSP polymer (6 g) + 1.2 ml of panchagavya
T_5 – TSP polymer (6 g) + 0.3 ml of vemiwash
T_6 – TSP polymer (6 g) + 0.6 ml of vemiwash
T_7 – TSP polymer (6 g) + 1.2 ml of vemiwash
T_8 – TSP polymer (6 g) + 0.12 g of humic acid
T_9 – TSP polymer (6 g) + 0.3 g of humic acid
T_{10} – TSP polymer (6 g) + 0.6 g of humic acid

Observations

i. Seed moisture content and ii. 1000 seed weight

Seed moisture content and 1000 seed weight was estimated as per the protocol in the seed testing manual (ISTA, 2013) [19]

The moisture content was calculated by using the following formula

$$\text{Moisture content} = \frac{W_2 - W_3}{W_2 - W_1} \times 100$$

Where,

W_1 - Weight of the empty container

W_2 - Weight of the container and seeds before drying

W_3 - Weight of the container and the seeds after drying

ii. Seed germination (%)

The germination test was carried out in roll towel method according to ISTA, 2013 [19] protocol. After seven days of germination, the seedlings were evaluated and the normal seedlings were counted and germination percentage (GP) was calculated, according to the formula:

Germination percentage (GP) = (Ng / Nt) × 100

Where Ng is a total number of normal seedlings germinated, Nt is a total number of seeds evaluated.

iii. Days for 50 per cent germination

In top of paper method, the number seeds germinated was recorded daily up to final count and number of days required for 50 per cent germination was computed (Heydecker and Coolbear, 1977) [18].

iv. Speed of germination (Maguire, 1962) [31]

Numbers of seeds germinated were counted daily up to seven days at the same time of day. From 1st day onwards up to 7th day. From the number of seeds germinated on each counting day, the speed of germination was computed adopting the formula.

$$\text{Speed of germination} = \frac{X_1}{Y_1} + \frac{X_2 - X_1}{Y_2} + \ldots\ldots\ldots + \frac{X_n - X_{n-1}}{Y_n}$$

X_1- Number of seeds germinated at first observation day

X_2- Number of seeds germinated at second observation day

X_n- Number of seeds germinated on n^{th} observation day

Y_1- Number of days from sowing to first observation day

Y_2- Number of days from sowing to second observation day

Y_n- Number of days from sowing to n^{th} observation day

v. Mean germination time: Germinated seeds were recorded daily up to seventh day at the same time of day. Mean germination time (MGT) was calculated according to Bailly *et al.* (2000) [4] using the formula:

$$MGT = \frac{\Sigma\,(Dn)}{\Sigma\, n}$$

Where, n is the number of seeds germinated on each day and D is the day of counting

vi. Endosperm and embryo degradation (Seed Metabolic Efficiency)

Amount of seed respired (SMR) was calculated as

SMR = SDW-(SHW+RTW+RSW)

Where,

SDW - Seed dry weight before germination

SHW - Shoot dry weight

RTW - Root dry weight

RSW - Remaining seed dry weight

Seed Metabolic Efficiency (SME) was calculated using the formula (Rao and Sinha, 1993) [39].

$$SME = \frac{SHW + RTW}{SMR}$$

vii. Root length and Shoot length

At the time of germination count, ten normal seedlings from each treatment and replication were used for measuring the root length and shoot length. Root length was measured from the collar region to the tip of primary root and the shoot length was measured from the collar region to shoot apex. The mean values were expressed in centimeter.

viii. Drymatter production (g seedlings^{-10}) and total drymatter production (g) (ISTA, 2013) [19]

The seedlings used for growth measurement and remaining normal seedlings were placed in a butter paper cover separately and dried in shade for 24 h and then kept in an oven maintained at 85 ± 2°C for 24 h. Dry weight was recorded and the mean values were expressed in gram. Total drymatter production was calculated by adding dry weight of 10 seedlings and dry weight of remaining normal seedlings.

ix. Vigour index (Abdul-Baki and Anderson, 1973) [1]

Vigour index values were computed using the following formula and the mean values were expressed in whole number.

Vigour index I = Germination (%) x Total seedling length (cm)

Vigour index II = Germination (%) x Drymatter production (g seedling^{-10})

Results

The result revealed that, seeds coated with TSP polymer and TSP polymer with stimulants shows non-significant difference for seed test weight and moisture content. Seeds treated with TSP polymer (T_1) shows non-significant effect on germination and seedling growth parameters compared to control. However significant difference was observed in TSP polymer with stimulants. Seeds treated with TSP polymer (6g) + 0.3 g humic acid (T_9) shows maximum germination (90%) compared to other treatments. Minimum germination was recorded in T_4 (84%), it was on par with T_0 (85%), T_1 (87%), T_2 (86%) and T_5 (87%) (Table1 and Fig. 1).

TSP polymer + stimulant reduced the abnormal seedling percentage compared to control. Maximum reduction was observed in T_9 and T_7 (4%) compared to other treatments. T_9 reduced the days for 50% germination (2.50) and mean emergence time (2.66) compared to other treatments. The maximum speed of emergence, seed metabolic efficiency, root length and shoot length were observed in seeds coated with TSP polymer (6g) + 0.3 g humic acid (T_9) (38.75, 1.52, 21.43 cm and 18.10 cm respectively) compared to control (32.27, 1.12, 18.49 cm and 15.33 cm) and other treatments (Table 1,2 and Fig. 2).

Highest dry matter production (DMP) was observed in T_7 (0.231 g), T_8 (0.230 g), T_9 (0.238 g) and T_{10} (0.236 g), which was on par with each other. Lowest dry matter production was observed in T_0 (0.215 g), T_1 (0.216 g), T_2 (0.221 g) and T_5 (0.222 g) which was on par with each other. Seeds coated with TSP polymer (6g) + 0.3 g humic acid (T_9) significantly increased the total DMP (2.17 g), vigour index-I (3597) and vigour index-II (21.66) compared to control (1.83 g, 2875 and 18.28 respectively) (Table 2 and Fig. 1).

Discussion

All the stimulants were slightly increased the germination and seedling performance but maximum improvement was observed in seeds coated with TSP polymer (6g) + humic acid (0.3g). TSP polymer with 0.3 and 0.6 ml of panchagavya promoted the germination rate and seedling growth performance and reduced the dead seed and abnormal seedling percentage compare to control. However TSP polymer with 1.2 ml of panchagavya reduced the germination rate and seedling growth performance compare to control, because higher concentration of panchagavya promotes the fungal invasion and showed toxic effect.

The germination improvement and growth promotion effect of panchagavya may be due to the presence of easily available organic C, N, P, K. These nutrients are very much required for plant growth (Kala and Eswari, 2019) [20]. The increase in shoot length and root length may be due to the presence of plant growth promoting substances produced by bacteria that are present in panchagavya (Naik and Sreenivasa, 2009) [34]. It is very interesting to note that application of panchagavya produced better root growth in beet root (Kumar *et al.,* 2020) [25]. Panchagavya has microbes such as *rhizobium*, azotobacter, azospirillum, phosphorus solubilizing bacteria and *lactobacillus*, that act as a liquid biofertilizer (Solaiappan, 2002) [43] and hence it promotes the seedling growth parameters. The results are in close conformity with the findings of Srimathi *et al.* (2013) [45] in Jatropha and Pungamia, Emily (2003) [16] in *Withania somnifera* (L) Dunal. Shoot length and root length were reduced with increasing concentration which might be due to optimal dose of the organic product which is normally specific to crop (Sumangala and Patil, 2009) [46].

All the concentrations of vermiwash, increased the germination percentage and seedling vigour. The reasons for increased seed physiological parameters may be due to the fact that vermiwash is coelomic fluid extract and contains several enzymes, plant growth hormones like, cytokinin, gibberline and vitamins along with micro and macro nutrients (Buckerfield *et al.,* 1999) [7]. Therefore, the growth promoting substances present in the vermiwash helps in seed germination and seedling vigour. The results are in conformity with the findings of Arjun Sharma and Deshpande (2006) [13] in pigeon pea and Deshpande *et al.,* (2008) [13] in Bengal gram. Similar results are also observed by Surendra *et al.,* (2005) [47] in greengram and cowpea, Shakila and Rajeswari (2008) [42] in okra, Suthara (2010) [48] in cluster bean, Narayanareddy and Biradarpatil (2012) [35] in sunflower and Rajan and Murugesan (2012) [38] in cowpea and Tiwari *et al.* (2018) [49] in chickpea.

The maximum germination percentage and seedling vigour was observed in seeds coated with TSP polymer with 0.3 g of humic acid. The germination and vigour improvement may be due to uptake of mineral elements by seeds. In many studies, humic acid was reported to increase the uptake of mineral elements (Maggioni *et al.*, 1987; De Kreij and Basar 1995; Mackowiak *et al.*, 2001) [30, 12, 29], promote the root length (Vaughan and Malcolm 1979; Canellas *et al.*, 2002) [50, 8] and increase the fresh and dry weight of seedlings (Kauser *et al.*, 1985; Chen *et al.*, 2004) [23, 9]. The dry weight and mineral nutrients uptake of corn has been found higher at application of humus compared to control (Khaled and Fawy, 2011) [24].

Humic acid, as a commercial product contains 44-58% C, 42-46% O, 6-8% H and 0.5-4% N, as well as many other elements (Larcher, 2003; Lee and Bartlett, 1976) [26, 27]. It improves soil fertility and increases the availability of nutrient elements by holding them on mineral surfaces. The auxin like activity of these humic substances in seedling influences the cell division and cell elongation (Mato *et al.,* 1971; Schnitzer and Weightman, 1974) [33, 41]. Research conducted using humic acid on seed germination, seedling vigor, yield and quality *etc.,* has been proved that humic acid is a miracles organic crop energizer (Lulakis and Petsas, 1995; Malik and Azam, 1985) [28, 32]. Humic substances are known to stimulate the germination of several varieties of agricultural seeds (Lulakis and Petsas, 1995; Malik and Azam, 1985, David, *et al.,* 1994; Dursun, *et al.,* 1999) [28, 32, 11, 15]. The immersion of seeds in a sodium humate solution was reported to increase germination, water absorption and respiration (David *et al.*, 1994) [11], the length of roots and shoots (Malik and Azam, 1985) [32] and the fresh and dry mass of roots and shoots (Lulakis and Petsas, 1995) [28].

Higher concentration of humic acid (0.6 g) reduced the germination rate and seedling vigour. It indicates that the positive effects of humic acid on seed germination and seedling growth is a concentration dependent phenomenon and may be due to hormone-like activity of humic acid on cellular respiration, photosynthesis, membrane permeability of cells, protein synthesis and various enzymatic reactions (Canellas *et al.,* 2002) [8]. The positive effects of humic acid on germination and growth of seedlings may also be due to better water absorption and transport of the stored materials to the root and shoot growth. Therefore, humic acid application helps in seed germination improvement, vigorous seedling establishment and maximum performance under field conditions.

Table 1: Effect of TSP polymer and biostimulants on seed physical and physiological parameters

Treatments	1000 seed weight (g)	Seed moisture content (%)	Abnormal seedling (%)	Dead seeds (%)	Days for 50% germination	Speed of germination
T_0	48.58	9.18	8	7	3.50	32.27
T_1	48.77	9.19	7	7	3.50	32.65
T_2	48.65	9.20	6	7	3.25	33.21
T_3	48.72	9.18	5	7	3.00	34.43
T_4	48.74	9.20	6	10	3.25	34.56
T_5	48.69	9.21	6	7	3.25	33.12

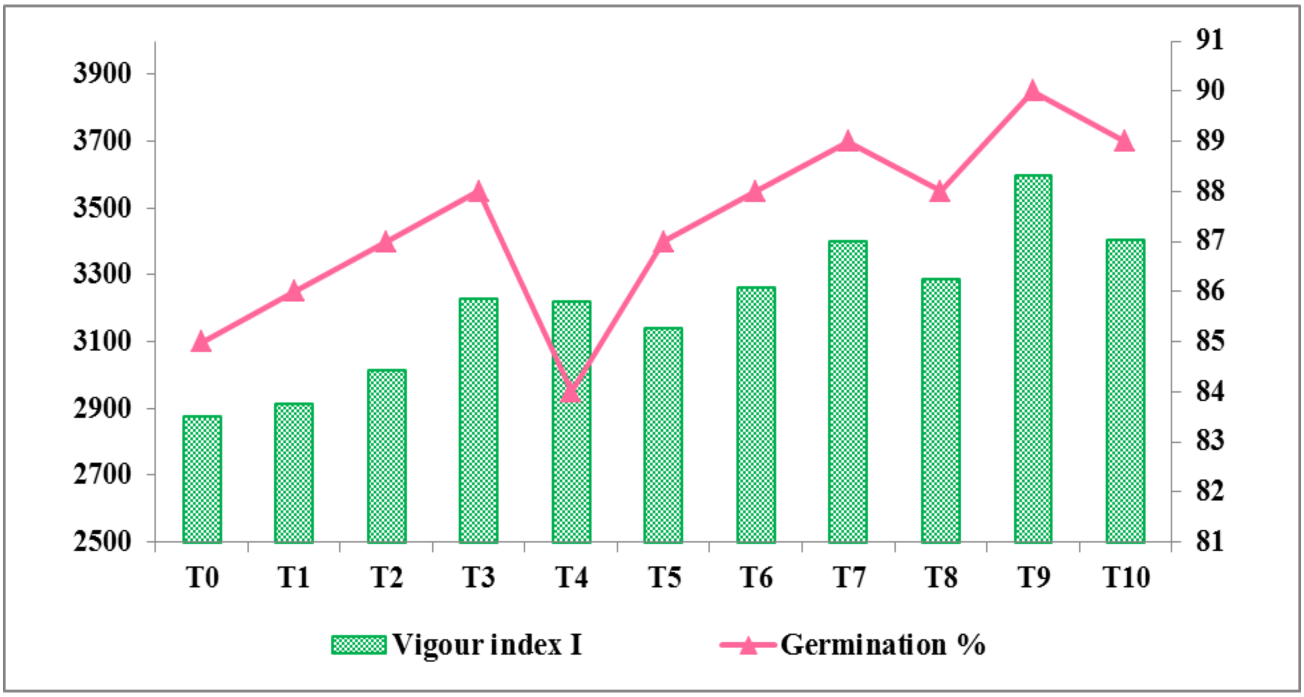
T_6	48.73	9.22	5	7	3.25	34.23
T_7	48.67	9.21	4	7	3.25	34.43
T_8	48.77	9.20	5	7	3.00	36.72
T_9	48.69	9.21	4	6	2.50	38.75
T_{10}	48.73	9.19	5	6	2.75	37.64
Mean	48.70	9.20	6	7	3.14	34.73
SEd	NS	NS	0.1223	0.1255	0.0720	0.8016
CD (P=0.05)	NS	NS	0.2536	0.2603	0.1493	1.6625

T_0 – Control; T_1 – TSP polymer (6 g/kg); T_2 – TSP polymer (6 g) + 0.3 ml of panchagavya; T_3 – TSP polymer (6 g) + 0.6 ml of panchagavya; T_4 – TSP polymer (6 g) + 1.2 ml of panchagavya; T_5 – TSP polymer (6 g) + 0.3 ml of vemiwash; T_6 – TSP polymer (6 g) + 0.6 ml of vemiwash; T_7 – TSP polymer (6 g) + 1.2 ml of vemiwash; T_8 – TSP polymer (6 g) + 0.12 g of humic acid; T_9 – TSP polymer (6 g) + 0.3 g of humic acid; T_{10} – TSP polymer (6 g) + 0.6 g of humic acid

Table 2: Effect of TSP polymer and biostimulants on seedling vigour parameters

Treatments	Mean emergence time	Seed metabolic efficiency	Shoot length (cm)	Root length (cm)	DMP (g/10 seedlings)	Total DMP (g)	Vigour index-II
T_0	3.47	1.12	18.49	15.33	0.215	1.83	18.28
T_1	3.42	1.16	18.51	15.38	0.216	1.86	18.58
T_2	3.39	1.21	19.23	16.12	0.221	1.90	19.01
T_3	3.12	1.26	20.45	17.23	0.227	2.00	19.98
T_4	3.24	1.08	19.12	16.44	0.223	1.87	19.69
T_5	3.35	1.18	19.32	16.76	0.222	1.93	19.31
T_6	3.27	1.25	19.76	17.28	0.228	2.01	20.06
T_7	3.25	1.37	20.34	17.87	0.231	2.06	20.56
T_8	3.14	1.31	20.12	17.21	0.230	2.02	20.24
T_9	2.66	1.52	21.43	18.10	0.238	2.17	21.66
T_{10}	2.83	1.43	20.22	18.02	0.236	2.10	21.00
Mean	3.19	1.26	19.73	16.89	0.226	1.98	19.85
SEd	0.0687	0.0306	0.3729	0.3292	0.0056	0.0468	0.4483
CD (P=0.05)	0.1424	0.0636	0.7734	0.6828	0.0116	0.0971	0.9298

T_0 – Control; T_1 – TSP polymer (6 g/kg); T_2 – TSP polymer (6 g) + 0.3 ml of panchagavya; T_3 – TSP polymer (6 g) + 0.6 ml of panchagavya; T_4 – TSP polymer (6 g) + 1.2 ml of panchagavya; T_5 – TSP polymer (6 g) + 0.3 ml of vemiwash; T_6 – TSP polymer (6 g) + 0.6 ml of vemiwash; T_7 – TSP polymer (6 g) + 1.2 ml of vemiwash; T_8 – TSP polymer (6 g) + 0.12 g of humic acid; T_9 – TSP polymer (6 g) + 0.3 g of humic acid; T_{10} – TSP polymer (6 g) + 0.6 g of humic acid



T_0 – Control; T_1 – TSP polymer (6 g/kg); T_2 – TSP polymer (6 g) + 0.3 ml of panchagavya; T_3 – TSP polymer (6 g) + 0.6 ml of panchagavya; T_4 – TSP polymer (6 g) + 1.2 ml of panchagavya; T_5 – TSP polymer (6 g) + 0.3 ml of vemiwash; T_6 – TSP polymer (6 g) + 0.6 ml of vemiwash; T_7 – TSP polymer (6 g) + 1.2 ml of vemiwash; T_8 – TSP polymer (6 g) + 0.12 g of humic acid; T_9 – TSP polymer (6 g) + 0.3 g of humic acid; T_{10} – TSP polymer (6 g) + 0.6 g of humic acid

Fig 1: Effect of TSP polymer and biostimulants on seed germination and vigour index-I

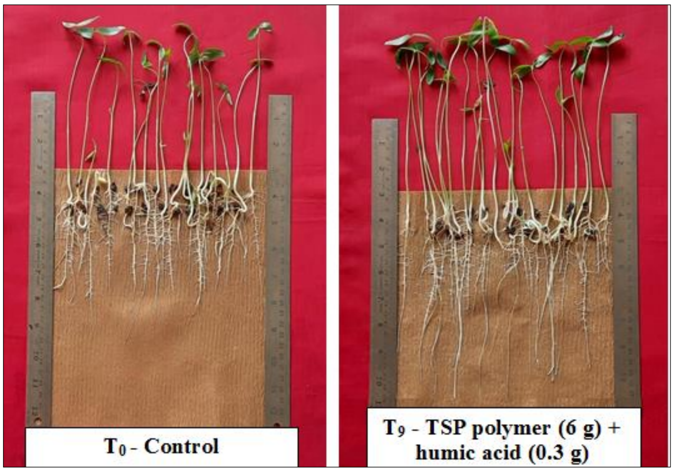


Fig 2: Seedling growth in T_0 (control) and T_9 (TSP polymer + humic acid (0.3 g))

Conclusion

Generally, the results of this study showed that TSP polymer + humic acid had a positive effect on seed germination and seedling vigour of black gram at lower concentration. It was revealed that among the various concentrations of humic acid, 0.3 g had the highest effect on seed germination properties. Higher concentration of humic acid had negative effect on seed physiological parameters. Coating of seeds (one kg) with TSP polymer (6g) + humic acid (0.3g) can qualitatively and quantitatively improves the seedling efficiency and also can substitute the use of synthetic polymers, chemical fertilizers and helps in reduction of environmental pollution. The present study was conducted in the lab conditions; further studies could be done to investigate the effect of TSP polymer + humic acid in the soil conditions.

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