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Unveiling Potential of Seed Planter and Drone for Sowing of Pelleted Seeds in Sesame (*Sesamum indicum* L.)

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ABSTRACT: An experiment was conducted to standardize the optimum pellet size for mechanized sowing in small sized sesame seeds. After standardization of pelleting protocol, the pelleting was carried out in the seed coating machine and the physical properties of the pellets were measured. In which, irrespective of different layers of pellets, the 100 seed weight of pelleted seeds increased over unpelleted seeds. The physiological parameters showed that the sesame seeds pelleted with 16 layers have recorded higher seedling vigour than unpelleted seeds. Therefore, it was optimized for sowing in the field by seed drill and drone. The field experiment results showed that sowing of pelleted seeds with air assisted seed drill was found suitable for maintenance of recommended plant population (11 plants/m^2). Maximum plant height (128.2 cm) was registered by pelleted seeds sown by inclined seed drill followed by line sowing with pelleted seed (127.7 cm) and the lowest plant height (125.1 cm) was recorded in broadcasting of unpelleted seed. Among the treatments, pelleted seeds sown by drone produced more number of branches (7.8/plant) and capsules (58.4/plant) and recorded 13.3% higher yield (746 kg/ha) than the unpelleted seed.

Keywords: Sesame, Seed pelleting, Seed germination, Seedling vigour, Mechanized sowing, Seed drill sowing, Drone sowing

INTRODUCTION

Sesame or gingelly (*Sesamum indicum* L.), also called as 'queen of oilseeds' is an important oilseed crop grown for its high quality oil and rich of nutritional facts. The sesame seed, contains approximately 50% oil, 25% protein and 15% carbohydrate, finds its application in baking, candy making and various other food industries. It is mostly cultivated in tropical and subtropical regions of Africa and Asia. The major producers of sesame include Sudan, India, Myanmar, Tanzania and China. Sudan is the largest producer of sesame in world, produced about 1.37 million tonnes followed by India with 0.80 million tonnes during 2025-26. In India, Gujarat, Rajasthan, West Bengal, Maharashtra, Uttar Pradesh, Tamil Nadu, Madhya Pradesh, Andhra Pradesh and Telangana are the major sesame growing states.

Sesame has small size seeds causing problems in sowing deep which prevents emergence from soil. The uneven spacing by broadcasting of seeds, excessive use of seeds for sowing, thinning to remove excess plants and labour involvement for thinning are some of the other related problems in the sesame cultivation. Therefore, increasing the size of the seed through pelleting technology avoids such kind of issues during seed germination and crop establishment. Pelleting is done by encapsulating the seed with any inert or foreign material which provides the uniform increase in size, shape and weight to seeds. During pelleting, seeds are stamped with adhesives and coated with filler materials and rolled to get uniform size. Such pelleted seeds are dried under shade. The pelleting method is mainly done to improve the size of the seed for mechanical sowing and to increase the vigour of the seedlings which is very essential for crop production [1]. Therefore, seed pelleting has good potential to overcome the issues during sowing and further emergence [2]. Also, the filler materials used for pelleting of seeds accomplishes the success of the pelleting technology particularly on improvement in shoot and root growth and further increase in yield [3].

Now-a-days, use of farm machineries become very important for precision in agriculture, time-saving, reduction in physical strain, reduction in labour cost, increase in efficiency and productivity. Particularly, sowing of seeds by machines has good scope in the agricultural system. It offers significant advantages including precision sowing, uniform depth, uniform spacing, improved seedling emergence, saving in seed and simultaneous fertilizer application. Further, it saves considerable time and labour with higher yield. Panning *et al*. [4] standardized the performance of the seed-metering device of a pneumatic planter for sorghum seeds including operational speed, vacuum pressure, miss index, multiple index, highest quality of feed index and seed spacing and they found that the machine was suitable for sorghum. Similarly, performance of pneumatic planter was assessed in the field for sorghum and the values of plant to plant spacing, multiple index, mean miss index, actual field capacity and field efficiency were found correspondingly to be 101 mm, 3.8%, 2.07%, 0.77 ha/h and 79.7% [5]. It is also demonstrated that the seed drill have a great potential for the seeding of barley and vetch so as to enhance the yield [6]. Raja *et al*. [7] found that the primed green gram seeds pelleted with pelleting mixture and sown by seed drill have recorded better plant establishment, growth and yield. Seed delivery systems like seed pellet, seed tape, seed capsule, seed mat and drone seeding which reduces the seed wastage by 20%, 50%, 40%, 60% and 10% respectively and offer practical, affordable alternatives for crop production [8]. Particularly, agricultural drone provides fast seed sowing and reduced working time [9]. Castro *et al*. [10] demonstrated aerial seeding with drone in forest restoration with reduced seed inputs and better seedling establishment which has great potential in the future system. Therefore, the present study was conducted to optimize the pellet size for mechanized sowing of sesame seeds and to evaluate its performance in the field through different methods of sowing.

MATERIALS AND METHODS

Standardization of optimum pellet size

The experiments for optimizing the pellet size for mechanized sowing of sesame seeds and sowing by different machines were conducted at Seed Centre, Tamil Nadu Agricultural University (TNAU), Coimbatore, India during 2023-25. Sesame variety TMV 7 seeds were obtained from Agricultural Engineering College and Research Institute (AEC&RI), Kumulur for pelleting of seeds. The pellet's size for sesame seeds was standardized by using TNAU pelleting mixture. During which, the 6% gum acacia wetting spray made over the seeds and the amount of pelleting mixture dusted over the seeds in each layer and the number of layers required to obtain pellets of required size of 2.5-3.0 mm diameter were optimized based on optical estimation of dusting, wettness and cracking of seed pellets.

After standardization of pelleting protocol, the pelleting was carried out in the seed coating machine and the physical properties of the pellets were measured by using Stereo microscope at Seed Centre, TNAU, Coimbatore *viz*., length and breadth of the pellet (mm). The 100 pelleted seed weight (g) was also recorded.

Spreading the seeds in a thin layer

⇓

Spraying of water/ adhesive over the seeds for uniform wetting

⇓

Transferring of wet seeds to a plastic container

⇓

Adding the pelleting powder to the seeds

⇓

Vigorous rotation of the plastic container to enable uniform distribution of pelleting powder over the seeds and to avoid multiple seeds

⇓

Continuation of the above steps for multiple times to achieve the seed pellets of required size

⇓

Size grade the seed pellets with appropriate sieves

⇓

Dry the pellets in a hot air oven at 40°C for 2 h

Figure 1. Standardization of pelleting protocol

Evaluation of seed pellets for quality parameters

Physiological properties of seed pellets *viz.*, germination and seedling vigour parameters were also assessed. Germination test for pelleted and unpelleted seeds was carried out in soil medium using 400 seeds with four replications comprising of 100 seeds per replication. Final count on normal seedlings was recorded on seventh day and percent germination was computed [11]. Randomly selected 10 normal seedlings were measured for root length (between collar region and tip of primary root), shoot length (from collar region to tip of leave) and expressed in centimeter. The vigour index value was calculated by multiplying the germination percentage with seedling length (shoot length + root length) as per the procedure given by Abdul-Baki and Anderson [12] and expressed in whole number. For determination of dry weight, the seedlings were dried in a hot air oven maintained at 85°C for 48 h and kept in a desiccator for 30 min and weighed in an electronic digital balance and mean dry weight was arrived and expressed as mg 10 seedlings^{-1}. The speed of germination was calculated based on the procedure given by Maguire [13], during which the protrusion of plumule from pelleted seeds were counted daily from sowing up to final count day and calculated the speed of germination as per the formula,

$$\text{Speed of germination} = \frac{X_1}{Y_1} + \frac{X_2 - X_1}{Y_2} + \ldots\ldots\ldots\ldots\ldots + \frac{Xn - Xn_{-1}}{Yn}$$

Where, X_1 - number of seeds germinated at 1st count; X_2 - number of seeds germinated at 2nd count; Xn - number of seeds germinated on nth count; Y_1 - number of days from sowing to 1st count; Y_2 - number of days from sowing to 2nd count; Yn - number of days from sowing to nth count. The pellets were also sown in the raised bed and field emergence percentage was calculated.

Evaluation of performance of seed pellets under field condition

The pelleted and un-pelleted sesame seeds were sown in the field at AEC&RI, Kumulur, Trichy District and farmer's field at Kurinjipadi, Cuddalore District. The seeds were sown using seed drill and drone as per the treatment details *viz.*, T_1 - Broadcasting with unpelleted seed, T_2 - Line sowing with unpelleted seed, T_3 - Broadcasting with pelleted seed, T_4 - Line sowing with pelleted seed, T_5 - Pelleted seed sowing with inclined seed drill, T_6 - Pelleted seed sowing with air assisted seed drill and T_7 - Pelleted seed sowing with drone. The recommended package of practices was followed for all the treatments. The field emergence, plant growth and yield traits were recorded at both the places.

The data collected in both the places were pooled and analysed statistically with SPSS 16.0 software. The critical difference (CD) values were calculated at 5% probability level [14].

RESULTS AND DISCUSSION

Standardization of optimum pellet size

Irrespective of different layers of pellets, the 100 seed weight of pelleted seeds in sesame was increased over unpelleted seeds. The seeds pelleted with maximum number of layers L_4 (18 layers of pelleting) showed the maximum 100 pelleted seed weight (3.48 g) than the L_1 (12 layers) (2.12 g). The length of the pellets increased from 2.14 mm to 3.15 mm (L_1 to L_4 layers) and breadth increased from 2.47 mm to 3.43 mm (L_1 to L_4 layers). The length of the pellet was increased up to 55% and breadth increased up to 49%. Total time required for disintegration of pellets was lesser for small pellets (2.4 min) and higher for larger pellets (5.2 min). The occurrence of double pellets was ranged from 5.0 to 7.7 and the maximum of 3.4 pseudo pellets was observed (Table 1). Similar results of seed pelleting in green gram with increased size and uniformity in shape were studied earlier [7].

Evaluation of seed pellets for quality parameters

Significant difference was observed in seed physiological parameters due to seed pelleting in sesame. The maximum speed of germination was recorded in unpelleted seeds (10.23) than larger sized pellets L_4 (8.16) (18 layers of pelleting). Similarly, the maximum germination was observed in unpelleted seeds (78%) than the larger sized pellets (76%). The highest root length was observed in L_3 (12.32 cm) and the lowest root length was recorded by L_0 (9.74 cm). The highest shoot length was registered in L_3 (8.63 cm) and the lowest shoot length was recorded by L_1 (7.17 cm) followed by L_0 (7.45 cm) (Table 2). The seed pellets of 16 layers (L_3) recorded the highest dry matter production (59.74 mg 10 seedlings^{-1}) and the lowest in L_0 (57.75 mg 10 seedlings^{-1}). No significant difference was observed in field emergence among the pellet size (Table 2). The growth promoting substances added in TNAU pelleting mixture facilitated nutrition, invigoration and protection to the sesame seeds which enhanced the germination and seedling vigour. Also, seed pelleting facilitates effectiveness in stimulating

Table 1. Effect of pelleting on physical properties of sesame seed

Treatments	100 pellet weight (g)	Length of the pellet (mm)	Breadth of the pellet (mm)	Percent increase in length	Percent increase in breadth	Time taken for disintegration of pellets (min)	No. of pseudo pellets (for 100 g)	No. of double pellets (for 100 g)
L_0 - Unpelleted control	0.45	2.04	2.17	-	-	-	-	-
L_1 - 12 layers (2.0 mm)	2.12	2.14	2.47	5	14	2.4	-	5.0
L_2 - 14 layers (2.2 mm)	2.53	2.48	2.68	22	24	3.5	-	6.4
L_3 - 16 layers (2.5 mm)	3.25	2.75	2.96	35	36	4.7	3.4	8.8
L_4 - 18 layers (3.0 mm)	3.48	3.15	3.23	55	49	5.2	2.0	7.7
Mean	2.37	2.51	2.70	29.25	30.75	3.95	2.70	6.98
SEd	0.03	0.007	0.005	3.10	2.72	0.002	-	0.14
CD (P=0.05)	0.07	0.014	0.011	6.23	5.46	0.005	-	0.29

Table 2. Effect of seed pelleting on physiological properties in sesame

Treatments	Speed of germination	Germination (%)	Root length (cm)	Shoot length (cm)	Dry matter production (mg 10 seedlings^{-1})	Vigour index	Field emergence (%)
L_0 - Unpelleted control	10.23	78	9.74	7.45	57.75	1341	76
L_1 - 12 layers (2.0 mm)	9.85	77	10.17	7.17	59.28	1335	75
L_2 - 14 layers (2.2 mm)	9.24	77	11.78	8.14	58.88	1534	75
L_3 - 16 layers (2.5 mm)	8.75	76	12.32	8.63	59.74	1592	74
L_4 - 18 layers (3.0 mm)	8.16	76	12.14	8.58	58.45	1575	74
Mean	9.25	76.8	11.23	7.99	58.82	1475	75
SEd	0.08	0.53	0.35	0.18	0.34	25	NS
CD (P=0.05)	0.15	1.07	0.72	0.37	0.69	52	NS

growth substances and avoids wastage of seed materials on broadcasting or soil application [15]. Jeephet *et al*. [16] reported that the pelleting of lettuce seeds with $CaSO_4$-zeolite using carboxymethyl cellulose was the most appropriated formula for enhancing germination and seedling vigour. Accordingly, to make seed pelleting successful, it is necessary to learn the physical properties of the seeds and their quality after being pelleted to confirm the complete results of seed pelleting formula development [17].

Evaluation of performance of seed pellets under field condition

The results of the field experiment showed that the percentage of emergence was higher in unpelleted seeds compared to pelleted seeds except drone sowing of pellets which recorded 13 percentage increase in emergence compared to manual broadcasting with unpelleted seeds. Sowing of pelleted seeds with air assisted seed drill is suitable for maintenance of recommended plant population (11 numbers/m^2) in sesame. Also, the fine tilth of soil and surface sowing of pellets facilitates the germination of pelleted seeds. The highest plant height (128.2 cm) was registered by pelleted seeds sown with inclined seed drill followed by line sowing with pelleted (127.7 cm) and the lowest plant height (125.1 cm) was recorded by broadcasting with unpelleted seed (Table 3). Among the treatments, pelleted seed sowing with drone produced more number of branches (7.8/plant) and more number of capsules (58.4/plant) whereas, plants from broadcasting with unpelleted seed recorded the lowest number of branches (5.6) and capsules (38.9). The maximum yield was obtained from pelleted seed sowing with drone (746 kg/ha) which was 13.3% increase over broadcasting of unpelleted seed (658 kg/ha).

Similar studies on enhanced emergence and seedling vigour through pelleted seed were studied earlier by many workers. Dogan and Zeybek [18] reported that seed pelleting was successful in sowing sesame seed and it significantly enhanced plant height, lateral branches and number of capsules per plant as compared to non-pelleted seeds. Further, the pelleted sesame seeds sown using seeders enabled successful crop establishment and yield performances compared to traditional practices [19]. Zhijun *et al*. [20] developed a rice direct sowing device compatible with the drone platform in which the yield is equivalent to that of the transplanting mode. Tenorio-Cruz *et al*. [21] found that drone seeding helps to provide great help in the development of the drudgery free farmer's activity in sowing of any crop.

Table 3. Effect of pelleted seed sown by seed drill and drone on field performance and yield in sesame

Treatments	Seed sown (g/m^2)	No. of seeds sown/m^2	Plant population (m^2)	Plant height (cm)	No. of branches/ plant	No. of capsules/ plant	Seed yield (kg/ha)
T_1- Broadcasting with unpelleted seed	0.5	111	85^b	125.1^a	5.6^f	38.9^f	658^e
T_2- Line sowing with unpelleted seed	0.5	111	73^c	126.9^a	6.2^e	45.5^e	677de
T_3- Broadcasting with pelleted seed	0.5 (3.5 g Pellet)	111	72^{cd}	127.1^a	7.2^c	48.7^d	692^{cd}
T_4- Line sowing with pelleted seed	0.5 (3.5 g Pellet)	111	70^d	127.7^a	7.5^b	52.6^c	715^{bc}
T_5- Pelleted seed sowing with inclined seed drill	0.34 (2.5 g Pellet)	76	58^e	128.2^a	7.6^{ab}	55.5^b	727^{ab}
T_6- Pelleted seed sowing with air assisted seed drill	0.05 (0.35 g Pellet)	11	9^f	127.5^a	6.8^d	45.3^e	706^{bc}
T_7- Pelleted seed sowing with drone	0.5 (3.5 g Pellet)	111	96^a	126.4^a	7.8^a	58.4^a	746^a
SEd			1.18	1.99	0.11	0.77	11.0
CD (P=0.05)			2.58	NS	0.24	1.69	24.1

CONCLUSION

Therefore, it is concluded that sesame seeds pelleted with 16 layers of TNAU pelleting mixture was found suitable for mechanized sowing in the field. Also, pelleted seeds sown by drone recorded 13.3% higher yield than the unpelleted seed.

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