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Research Article

Registration of Pawe-01 and Pawe-02 Released Soybean (*Glycine max* (L.) Merrill) Varieties

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Abstract

Soybean (*Glycine max* (L.) Merrill) is an essential crop in Ethiopia, valued for its role in food production, animal feed, soil fertility improvement, and industrial applications. Despite its growing importance, national average yields remain lower than the global standard due to biotic and abiotic stresses, limited genetic diversity, and the declining potential of released varieties. To address these challenges, the Pawe Agricultural Research Center has introduced and tested various soybean germplasms and commercial varieties from Brazil, the United States, Malawi, and Nigeria since 2010Soybean National variety Adaptation trial comprising of 5 varieties namely; PB12-2, PB12-3, and PB12-9 along with Belessa-95 and Wegayen as a standard check were evaluated at Pawe in 2013 and at Pawe, Humera, Jimma, Assosa, Sirinka and Areka in 2014. Based on the data generated in 2013 and 2014 testing seasons, two promising candidate varieties namely PB12-2 and PB12-3 were selected for their higher grain yield, Number of branches and effective nodules per plant and for other important characters to be verified and evaluated in 2015 cropping season. After extensive multi-location trials, these varieties were officially registered as "Pawe-01" and "Pawe-02" and are now under production in key soybean-growing regions of Ethiopia. Their superior traits make them promising options for enhancing soybean productivity and sustainability in the country.

Keywords

Soybean, Variety, Verification, Yield Performance

1. Introduction

Soybean (*Glycine max* (L.) Merrill) is a versatile crop with multiple uses, including food production, animal feed, malnutrition alleviation, soil fertility enhancement, and serving as a raw material for various industrial processes. Ethiopia has significant potential for soybean cultivation, as it is well-suited for intercropping with maize and sorghum, as well as for crop rotation in irrigated farming systems with cotton and wheat. Beyond its economic benefits, soybean plays a crucial role in sustainable agriculture by replenishing soil fertility [1-3].

In Ethiopia, soybean is well adapted to the country's lowland to mid-altitude agro-ecological zones [4]. During the 2020–2021 cropping season, soybean was cultivated on 108,665.6 hectares, with a national average yield of 2.5 tons

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per hectare [5]. While soybean is primarily grown by smallholder farmers, its cultivation is expanding among medium-scale and commercial farmers due to rising industrial demand. Over the past twelve years, the total area under soybean production has increased from 5,679 hectares to 108,665.6 hectares. During the same period, total production has risen from 7,205 tons to 208,676 tons, while productivity has improved from 1.3 to 2.5 tons per hectare [5].

However, the average productivity of soybean in Ethiopia remains lower than the global average, which exceeds 3 tons per hectare [6]. This yield gap is primarily attributed to biotic and abiotic stresses [7], limited genetic diversity in soybean germplasm, and the declining genetic potential of released varieties [8]. To address these challenges, the Pawe Agricultural Research Center has been actively developing high-yielding, disease-resistant soybean varieties with improved seed oil content and other desirable agronomic traits to enhance productivity in the country.

Since 2010, the center has introduced and evaluated various soybean germplasms and commercial varieties from Brazil, the United States, Malawi, and Nigeria (sourced from IITA). These materials have undergone extensive testing for disease resistance, quality, and yield performance through successive trial stages. In 2012, three commercial varieties PB12-2, PB12-3, and PB12-9 were introduced from Brazil and evaluated over two consecutive years. Among them, PB12-2 and PB12-3 demonstrated superior disease resistance, grain yield, and overall agronomic performance compared to the standard check variety (Wegayen) and the local check variety (Belessa-95) (Tables 2 & 3). Consequently, these two varieties were officially registered under the names “Pawe-01” and “Pawe-02” and are now being cultivated in suitable agro-ecological zones, including Pawe, Assosa, Bako, Sirinka, Areka, Jimma, Gonder, and similar regions.

2. Materials and Methods

2.1. Experimental Materials and Test Locations

Only three candidates introduced (from Brazil in 2012) commercial and two released soybean varieties (Table 1) have been tested as adaptation trial after two consecutive years in 2013 and 2014. The tested materials were subjected for evaluating yield and other agronomic performances. The candidate materials are commercial varieties and introduced, which were under production, in abroad. Since the candidate varieties were already released varieties we have conducted adaptation trial in a single year (2013) at Pawe and at six different locations (Pawe, Assosa, Awasa, Areka, Humera, Sirinka and Jimma) in 2014. A variety verification trial for registration has been conducted in 2015 in a single plot (10m*10) standard at three different locations across the country.

The grain yield and other yield component yield advantage (%) were computed according to the formula adopted from [9].

$$\text{Yield advantage (\%)} = \frac{\text{mean yield of candidate variety (kgha}-1) - \text{mean grain yield of the check(kgha}-1) * 100}{\text{Yield of the check}}$$

2.2. Candidate Description Before and After Registration

Crop (with Latin name): Soybean [*Glycine max* (L.) Merrill] Variety designation

a) PB12-2

b) PB12-3

Given name after registration (breeders’ preference):

a) PB12-2 designated as Pawe-01

b) PB12-3 designated as Pawe-02

2.3. Merits of the Registered Varieties

Higher grain yield

PB12-2 showed 23.89% and 33.32% yield advantages over the standard check Belesa-95 and Wegayen, respectively, whereas PB12-3 showed 15.72% and 24.54% yield advantage over the standard checks, respectively (Table 6). In line with this result, [10] reported that 35.6% yield advantage of the candidate genotype Tgx-1989-75F over the standard check variety of Pawe-03.

Higher Numbere of branches per Plant

PB12-2 and PB12-3 showed 15% of number of branches per plant advantage over the standard check Belessa-95 and Wegayen (Table 7).

Higher number of effective nodule per plant

PB12-2 and PB12-3 showed 35% of effective nodule number per plant advantage over the standard check Belessa-95 and Wegayen (Table 8). This better advantage implies that the new varieties being more preferable for fixing atmospheric nitrogen as fertilizer and for soil improvement purpose.

Table 1. Number of years and testing locations.

Variety	Source	Year of introducing/released	Testing year	Number of testing locations
PB12-2	Brazil	2012	2013	1
PB12-3	Brazil	2012	2014	5
PB12-9	Brazil	2012		
Wegayen	PARC	2010		
Belessa-95	HARC	1995		

Table 2. The yield and yield components mean values of Soybean Variety Adaptation Trial evaluated at Pawe in 2013.

S/no	Variety	DF	DM	NN	PH (cm)	PPP	SPP	Bra	HSW (gr)	Yield ($kgha^{-1}$)
1	PB12-2	60	130	35.2	70.0	27.2	2.6	4.0	17.28	2700
2	PB12-3	61	132	47.0	74.0	29.6	2.4	3.6	14.35	2400
3	PB12-9	64	133	27.0	48.0	27.8	2.0	3.2	12.14	1100
4	Belesa-95	62	127	20.2	58.2	25.7	2.6	3.0	14.40	1980
5	Wegayen	59	116	18.7	62.3	22.1	2.6	2.5	14.0	1860
Mean		61.2	124.6	28.4	62.5	26.5	2.4	3.3	14.4	1750.9

Table 3. The yield components mean values of Soybean Variety Adaptation Trial evaluated across six locations in 2014.

S/no.	Treat	DF	NOD	DM	PPP	PH	SPP	BrPP	HSW
1	PB12-2	58.06	5.38	109.78	53.69	66.97	2.55	5.56	13.93
2	PB12-3	58.50	7.42	109.71	51.51	64.40	2.39	5.41	13.28
3	PB12-9	56.50	8.23	110.50	43.88	58.54	2.35	5.04	14.04
4	Belesa-95 (Local Check)	59.33	9.80	115.06	51.05	83.43	2.54	4.71	13.00
5	Wegayen (Standard check)	52.28	6.28	108.44	43.88	75.42	2.22	4.31	14.18
Mean		56.93	7.42	110.70	48.80	69.75	2.41	5.01	13.69

Table 4. The grain yield mean values of soybean varieties at six locations in 2014.

S/no.	Varieties	Grain Yield ($kgha^{-1}$)						
		Areka	Assosa	Humera	Jimma	Pawe	Sirinka	Mean
1	PB12-2	3486.42	1731.38	1284.77	2210.87	2291.15	2443.15	2241.29
2	PB12-3	3119.89	1623.81	1110.28	2410.49	2481.83	2547.50	2215.63
3	PB12-9	2537.59	1133.12	1122.78	1995.79	943.17	1990.74	1620.53
4	Belesa-95 (S. Check)	3176.89	1295.70	867.96	2112.73	2170.40	2427.41	2008.52
5	Wegayen	2841.76	1375.91	1043.38	1908.16	1686.97	2220.56	1846.12

Table 5. Yield and Yield component over all mean values in 2013 and 2014..

S/no.	Variety	DF	NN	DM	PPP	PH	SPP	Bra	HSW	Grain Yield (kgha^{-1})
1	PB12-2	59.03	20.29	119.89	40.45	68.49	2.58	4.78	15.61	2470.65
2	PB12-3	59.75	27.21	120.86	40.56	69.20	2.40	4.51	13.82	2307.82
3	PB12-9	60.25	17.62	121.75	35.84	53.27	2.18	4.12	13.09	1360.27
4	Belesa-95(St.ch 1)	60.67	15.00	121.03	38.38	70.82	2.57	3.86	13.70	1994.26
5	Wegayen (St.ch 1)	55.64	12.49	112.22	32.99	68.86	2.41	3.41	14.09	1853.06
Grand mean		59.07	18.52	119.15	37.64	66.13	2.43	4.13	14.06	1997.21

Where, DF: days to 50% flowering, NN: Number of effective nodules per plant, DM: Days to 95% maturity, PPP: Number of pods per plant, PH: Plant height (cm), SPP: Number of seeds per pod, Bra: number of branches per plant and HSW; Hundred seed weight (gr).

Table 6. The yield advantages (%) of the candidates over the checks.

Yield (kgha^{-1})				Yield advantage (%) of			
Candidate 1 (PB12-2)	Candidate 2 (PB12-3)	Standard check 1 Belessa-95	Standard check 2 Wegayen	Candidate 1 over standard Check 1	Candidate 1 over standard check 2	Candidate 2 over standard check 1	Candidate 2 over stand check 2
2470.65	2307.82	1994.26	1853.06	23.89	33.32	15.72	24.54

Table 7. The Number of branches advantages (%) of the candidates over the checks.

Number of Branches per plant				Number of Branches per plant advantage (%) of			
Candidate 1 (PB12-2)	Candidate 2 (PB12-3)	Standard check 1 Belessa-95	Standard check 2 Wegayen	Candidate 1 over Standard check 1	Candidate 1 over Standard check 2	Candidate 2 over Standard check 1	Candidate 2 over Standard check 2
4.78	4.51	3.86	3.41	23.83	40.18	16.84	32.26

Table 8. Number of Effective nodule advantage (%) of the candidates over the standard checks.

Number of nodule per plant				Number of nodule per plant advantage (%) of			
Candidate 1 (PB12-2)	Candidate 2 (PB12-3)	Standard check 1 Belessa-95	Standard check 2 Wegayen	Candidate 1 over Standard check 1	Candidate 1 over Standard check 2	Candidate 2 over Standard check 1	Candidate 2 over Standard check 2
20.29	27.21	15.0	12.49	35.27	62.45	81.4	117.85

Table 9. Agronomical and Morphological characteristics of the registered varieties.

Characteristics	Measurement or description	
	PB12-2 (Pawe-01)	PB12-3 (Pawe-02)
Days to 50% flowering	58.06	59
Days to 95% maturity	110	110
Maturity group	Medium to late	Medium to late
Seed color	Light yellow	Light yellow
Number of Pods/plant	27.2	29.2
Number of seeds/pod	2.6	2.4
Plant height (cm)	66.97	64.4
Hundred seed Weight (gr)	13.93	14.35
Oil content (%)	21	22
Altitude (m.a.s.l)	520-1800	520-1800
Rain fall (mm)	460-1600	460-1600
Planting date	Mid June to early July	Mid June to early July
Fertilizer (DAP)	100kg/ha at planting	100kg/ha at planting
Seed rate	60-80kg/ha	60-80kg/ha
Adaptation areas	Pawe, Dangur, Guba, Bulen, Dibate, Assosa, Gonder, Bako, Areka Srinka and similar areas	Pawe, Dangur, Guba, Bulen, Dibate, Assosa, Gonder, Bako, Areka Srinka and similar areas.
Yield ($kgha^{-1}$) at research	2443	2558
Yield ($kgha^{-1}$) at farmers' field	1836	1763
Breeder /maintainer	Pawe ARC	Pawe ARC
Year of Release	2015	2015

3. Conclusion

The introduction and evaluation of new soybean varieties are crucial for addressing Ethiopia's soybean productivity gap. The adaptation trials conducted on PB12-2 and PB12-3 demonstrated significant agronomic advantages over existing check varieties in terms of branching, nodule formation, and grain yield. These varieties, now officially registered as "Pawe-01" and "Pawe-02," offer superior productivity and resilience, making them well-suited for Ethiopia's diverse agro-ecological zones. Their ability to enhance nitrogen fixation also contributes to improved soil fertility, benefiting subsequent cropping systems. The successful registration and commercial adoption of these varieties mark a significant step in strengthening Ethiopia's soybean sector, supporting both smallholder and commercial farmers in meeting the increasing demand for soybean in the country.

Abbreviations

Pawe Arc	Pawe Agricultural Research Center
St. check	Standard Check

Author Contributions

Asmamaw Amogne Mekonen: Conceptualization, Data curation, Formal Analysis, Funding acquisition, Investigation, Methodology, Software, Supervision, Validation, Visualization, Writing – original draft,

Mola Malede: Investigation, Methodology, Writing – review & editing

Tizazu Degu: Methodology, Project administration, Resources

Gezahegn Tefera: Formal Analysis

Tadesse Ghidey: Supervision

Conflicts of Interest

The authors declare no conflicts of interest.

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