From Seed to Sod: Investigating the Role of Growing Media in Turf Grass Germination for Premium Sod Quality

ABSTRACT

Aims: Our study aimed to address the low seed germination potential in turf grasses by using cost-effective growing media. The study was conducted at experimental farm of department of floriculture and landscaping in the year 2021-2022 in two experiments conducted during both the years in February-March. Three different cost-effective growing media; garden soil (T1), mixture of garden soil and leaf manure (2:1) (T2) and mixture of sand and leaf manure (2:1) (T3) were filled in growing trays and then seeds of four cool season turf grasses (perennial ryegrass, tall fescue, creeping bentgrass and creeping red fescue) were sown thinly in respective media. Experiment was conducted in completely randomized block design including 3 replications and daily germination counts were taken till 15 days. Data recorded was analysed using OPSTAT software and critical difference was calculated at 5% level of significance. The study highlights the superiority of 2:1 ratio garden soil and leaf manure for better germination attributes. This medium significantly reduces germination time, enhances seedling attributes, and proves optimal for achieving maximum seedling vigor which can contribute subsequently to uniform sod establishment.

Keywords: Turfgrasses; cool season; growing media; seed germination

1. INTRODUCTION

Cool-season turfgrasses, thriving in cooler climates, are well-suited for regions with cold winters and moderate summers. Optimal growth occurs in temperatures ranging from 60°F to 75°F (15°C to 24°C). In subtropical climate, like north-Indian plains, warm season grasses become dormant in chilling winters where over-seeding with cool-season turf grasses can be used to maintain lush green appearance which is usually a common practices in transition zones [1].Commonly used species among cool season turf grasses are; bluegrasses (*Poa sp.*), fine fescues (*Festuca* sp.), ryegrasses (*Lolium sp.*), and bent grasses (*Agrostis sp.*) Fine fescues, which include chewings fescue (*Festuca rubra ssp. commutata*), creeping red fescue (*Festuca rubra*), and sheep fescue (*Festuca ovina*), hard fescue (*Festuca trachyphylla*), are valued for their shade tolerance and adaptability. Tall fescue (*Festuca arundinacea*) is prized for its drought resistance and durability, making it suitable for various applications. Perennial ryegrass is known for its quick germination and establishment, contributing to the rapid development of lush lawns. Creeping Bentgrass (*Agrostis stolonifera*) is highly valued for its fine texture, dense growth habit, and ability to form a dense, carpet-like turf. Native to Europe but widely used in various regions, it has become a popular choice for golf courses, especially for putting greens [2].

In landscape gardening, it is essential to maintain a consistently green and unified landscape. This involves careful upkeep to ensure a lush appearance all year round. Grass plays a vital role by not only reducing noise but also controlling soil erosion, offering various environmental benefits, and enhancing our overall quality of life. Choosing the right turf species for landscaping depends on factors like climate suitability, the type of garden, following appropriate care practices, and having the necessary maintenance skills. The turfgrass market has expanded quickly in an effort to satisfy the public's rising needs for goods and services. Certain techniques impact the rate at which a new turf establishes itself, especially the growing materials used during propagation [3].

Seed germination is the crucial phase in the life cycle of plant and maintaining ideal conditions during this phase is necessary [4]. One of the major identidfied factors that limits germination and subsequent development of a seedling is low soil moisture availability [5]. The composition of the growing medium plays a crucial role in the nursery, influencing seed germination, seedling growth, and the overall quality of seedlings [6]. Factors such as aeration and water retention under low matric potentials are identified as key contributors to plant growth within the medium [7]. Managing these aspects in the growing medium is essential for creating an environment that supports robust seed germination, healthy seedling development, and successful nursery cultivation practices. There are two types of soils that are used in the establishment of turfgrasses; native soils and sand-based soils [8]. Commonly used media in turf grasses are either soil based or sand based and both have their pros and cons. Regular native soil as a medium is cheaper and easily available, but, sometimes, tightly packed soil can cause compaction and can hinder the roots from growing well even when favourable temperatures and moisture levels are present. On the other hand, sand-based media have the capacity to facilitate gas exchange in the root zone, increase rooting depths, boost water infiltration and drainage through the root zone, and provide resistance to compaction, but it does not provide enough anchorage to the plants. Sand-based media are especially significant for sports fields and golf courses that are exposed to inclement weather [8]. For seed germination seed requires enough moisture, where soil-based media are having more potential than sand. Further, supplementing the soil with organic matter like leaf manure, vermicompost, vermiculite, perlite, and cocopeat can provide essential nutrients for growing seedlings. It serves a crucial role in seed germination, acting not only as support but also as a source of vital nutrients for plant growth. The makeup of the medium directly impacts the quality of the seedlings.

Therefore, this study was undertaken to assess the impact of soil and sand based growing medium on the seed germination of turfgrasses, aiming to enhance the quality of sod production.

2. MATERIAL AND METHODS

The present investigation was undertaken in the experiment farm area of Floriculture and Landscaping Department, Punjab Agricultural University, Ludhiana, Punjab, during 2021-2022 (February-March). First germination experiment was conducted in February 2021 and then repeated in 2022 for validation of results. Average data of both the experiments were taken to compile final results. Temperature (^{o}C) and relative humidity (%) during the study period has been depicted in Figure 1 Seeds of cool season turfgrasses used for the present study were procured from Peak Traders, New Delhi. The experiment was carried out in Completely Randomized Design (CRD) with factorial arrangement having three replications.

The experiment included four cool season turf grass genotypes (perennial ryegrass (*Lolium perenne*), tall fescue (*Festuca arundinacea*), creeping bentgrass (*Agrostis stolonifera*), and creeping red fescue (*Festuca rubra* subsp. *rubra*)) and 3 different growing media combinations viz., T_1– garden soil, T_2-garden Soil + leaf manure (2:1) and T_3- sand + leaf manure (2:1).The prepared growing media combinations were filled in the trays (60 cm x 30 cmx 5cm dimensions) as per the treatment. 100 seeds were sown per replication *i.e* 300 seeds per treatment. Seeds were sown carefully by dropping one seed at one place and then trays were placed under 35% shade and watered lightly using rose can. Germination counts were taken daily for the germinated seeds up to 15 days of sowing and at end of 15th

day total number of seeds germinated were counted. Observations for seedling length, seedling fresh weight, seedling dry weight, moisture contents and vigour index were taken from 10 uniform seedlings in each treatment. Formulas used for calculation were;

Germination percentage (%) = Number of seeds germinated/Total number of seeds sown × 100

Seedling vigour index (SVI) was calculated following the modified formula [9].

SVI = shoot length (mm) × germination percentage

Data recorded for each parameter was subjected to analysis of variance (ANOVA) using completely randomized design (factorial). Software used for analysis was OPSTAT.

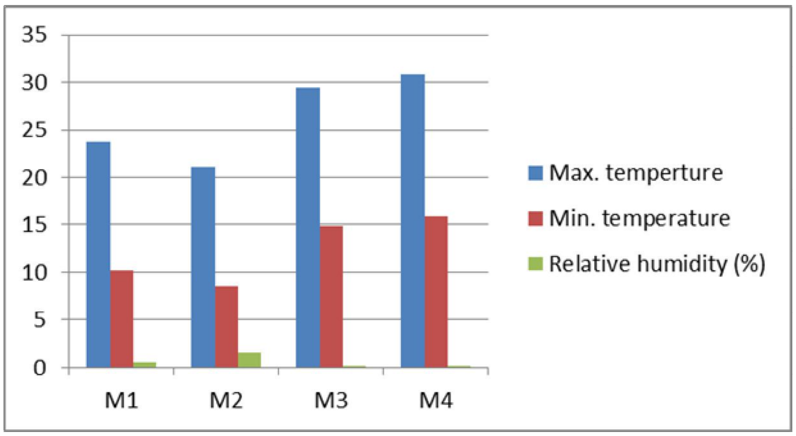


Figure 1: Temperture (^{o}C) and relative humidity (%) during study period; M1: February 2021; M2; February 2022; M3: March 2021; M4: March 2022.

3. RESULT AND DISCUSSION

3.1. Effect of genotypes

In the assessment of various grass species, different variations were observed in terms of germination characteristics and seedling development (Table 1). Perennial Ryegrass exhibited early germination (6.88 days) followed by Tall fescue (7.98 days) and Creeping Red fescue (9.39 days). Maximum no. of days to germination was observed in Creeping Bent (10.6 days). Highest germination percentage (90.11) was observed in perennial ryegrass followed by tall fescue (74.55%), creeping bent grass (57.22%) and creeping red fescue (53.33%). When assessing seedling characteristics, Perennial Ryegrass demonstrated the maximum seedling length (7.82 cm) followed by tall fescue (7.46 cm), creeping bent grass (7.37 cm) and minimum seedling length was recorded in creeping red fescue (6.72 cm). Vigour index, a crucial measure of overall seedling health, was found maximum in perennial ryegrass (612.7) whereas, minimum vigour index was recorded in

Creeping bent (415.6). The maximum seedling fresh weight was recorded in tall fescue (20.3g) followed by perennial ryegrass (19.1g) and creeping bent (16.6g). Conversely, minimum seedling fresh weight was found in creeping red fescue (15.3g). The seedling dry weight mirrored a similar trend, with tall fescue recorded maximum seedling dry weight (2.7g) followed by perennial ryegrass (2.3g) and creeping bent (2.0g). Conversely, minimum seedling dry weight was found in creeping red fescue (1.6g). Examining seedling moisture content, maximum was recorded in creeping red fescue (89.9%) followed by perennial ryegrass (88.1%) and creeping bent (88.1%). Conversely, minimum seedling moisture content was found in tall fescue (86.7%).

Table 1: Germination potential in different cool season turfgrasses irrespective of growing medium.

Genotypes	Days to germination	Percent germination (%)	Seedling length (cm)	Vigor index	Seedling fresh weight (g)	Seedling dry weight (g)	Seedling moisture contents (%)
PRG	6.88	90.11	7.82	612.7	19.1	2.3	88.1
TF	7.98	74.55	7.46	463.34	20.3	2.7	86.7
CB	10.6	57.22	7.37	415.6	16.6	2.0	88.1
CRF	9.39	53.33	6.72	506.58	15.3	1.6	89.9
C.D. at 5% level of significance	0.17	1.90	0.17	11.43	0.5	0.2	1.0

* PRG: Perennial rye grass; TF: Tall fescue; CB: Creeping bent grass; CRF: Creeping red fescue

3.2. Effect of growing media

Seed germination parameters were influenced by growing media as depicted in Table 2. In terms of days to germination, the minimum no. of days taken for the germination from the day of sowing was observed in the treatment T_2 (garden soil + leaf manure (2:1) with 8.17 days followed by T_1 (garden soil) (8.90 days). In contrast, the maximum days to germination was observed in T_3 (sand + leaf manure) (9.04 days). The maximum germination percentage (78.16%) was recorded in T_2 (garden soil + leaf manure) which was found to be statistically at par with T_1 (garden soil) (72.08%). Minimum germination (56.16%) was recorded in T_3 (sand +Leaf manure). Maximum seedling length was recorded in T_2

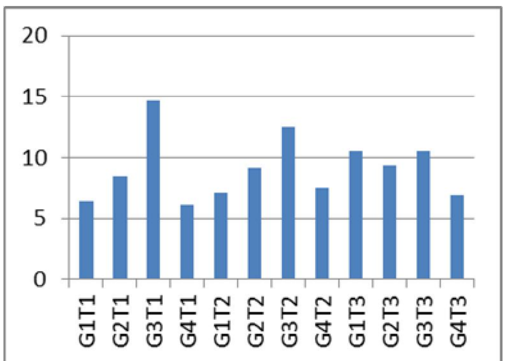
(garden soil + leaf manure) which is 7.83 cm followed by T_1 (sand+ leaf manure) (7.23 cm). The minimum seedling length was recorded in T_3 (sand+ leaf manure) which is 6.92 cm. In terms of vigour index, highest vigour index (512.13) was recorded in T_2 (garden soil + leaf manure) which was statistically at par with T_1 (garden soil) (505.25). Conversely, lowest vigour index (481.35) was found in T_3 (sand+ leaf manure). The maximum seedling fresh weight was observed in T_2 (garden soil + leaf manure) (19g) whereas, minimum seedling fresh weight was found in T_3 (sand+ leaf manure) (16.2g). Similarly, maximum seedling dry weight was observed highest in T_2 (garden soil + leaf manure) (2.3g) which was found to be statistically at par with T_1 (garden soil) (2.2g) whereas, minimum seedling dry weight was found in T_3 (sand+ Leaf manure) (1.9g). Seedling moisture content for growing media was found to be non-significant.

Table 2: Effect of growing media on germination attributes of different cool season turfgrass species.

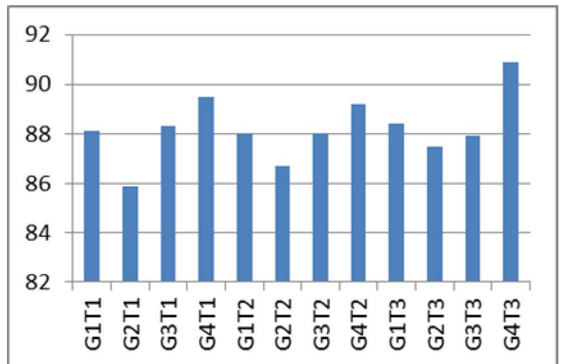
Growing media	Days to germination	Percent Germination (%)	Seedling length (cm)	Vigor index	Seedling fresh weight (g)	Seedling dry weight (g)	Seedling moisture content (%)
T_1 (Garden Soil)	8.90	72.08	7.28	505.25	18.2	2.2	87.9
T_2 (Soil+leaf manure 2:1)	8.17	78.16	7.83	512.13	19.0	2.3	88.0
T_3 (Sand+ Leaf manure 2:1)	9.04	56.16	6.92	481.35	16.2	1.9	88.7
C.D. at 5% level of significance	0.17	1.37	0.15	9.90	0.4	0.2	NS

3.3. Interaction effect between genotypes and growing media

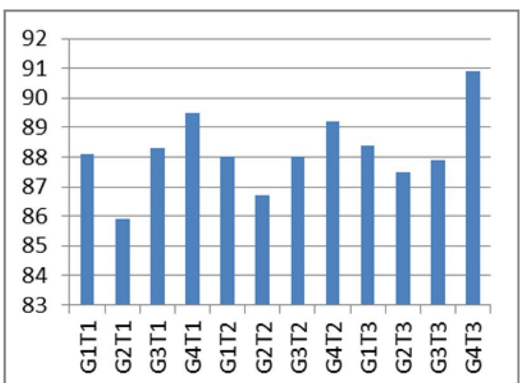
Figure 2 shows the interaction of genotypes with growing media. For days to germination, perennial ryegrass exhibited earlier germination (4.5 days) when grown in T_2 (garden soil + leaf manure (2:1)), while creeping bent recorded the maximum number of days to germinate (14.7days) in T_3 (sand media+ leaf manure (2:1)). In terms of germination percentage, the highest (90.11%) was observed in perennial ryegrass when grown in T_1 (garden soil+ leaf manure), and the lowest (53.33%) was recorded in creeping red fescue when grown in T_3 (sand+ leaf manure). In terms of seedling characteristics, maximum seedling length (9.3 cm) was recorded in perennial ryegrass when grown in T_2 (garden soil + leaf manure), and the minimum (5.07 cm) was recorded in creeping red fescue in T_3 (sand+ leaf manure). Similarly, for vigour index, the highest value (786.8) was observed in perennial ryegrass in T_2 (garden soil + leaf manure), and the lowest (199.8) was found in creeping red fescue in T_3 (sand+ leaf manure). Interaction between growing media and grass genotypes were found non-significant for seedling fresh weight, seedling dry weight and seedling moisture contents. Further it is interesting to note that seedling length and vigor index of creeping bent grass was found highest (8.43 cm and 786.8) in sand based media (T_3: Sand + leaf manure) rather than T_2 and T_1



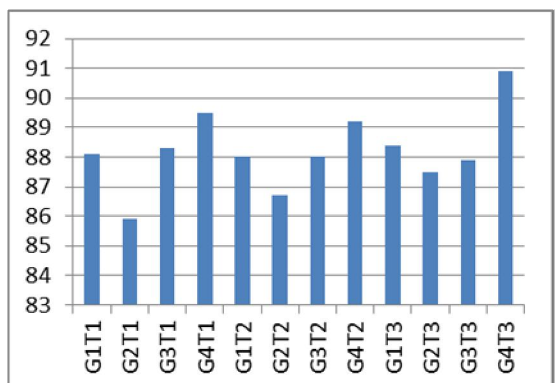
Days to germination



Percent germination (%)



Seedling length (cm)



Vigor index

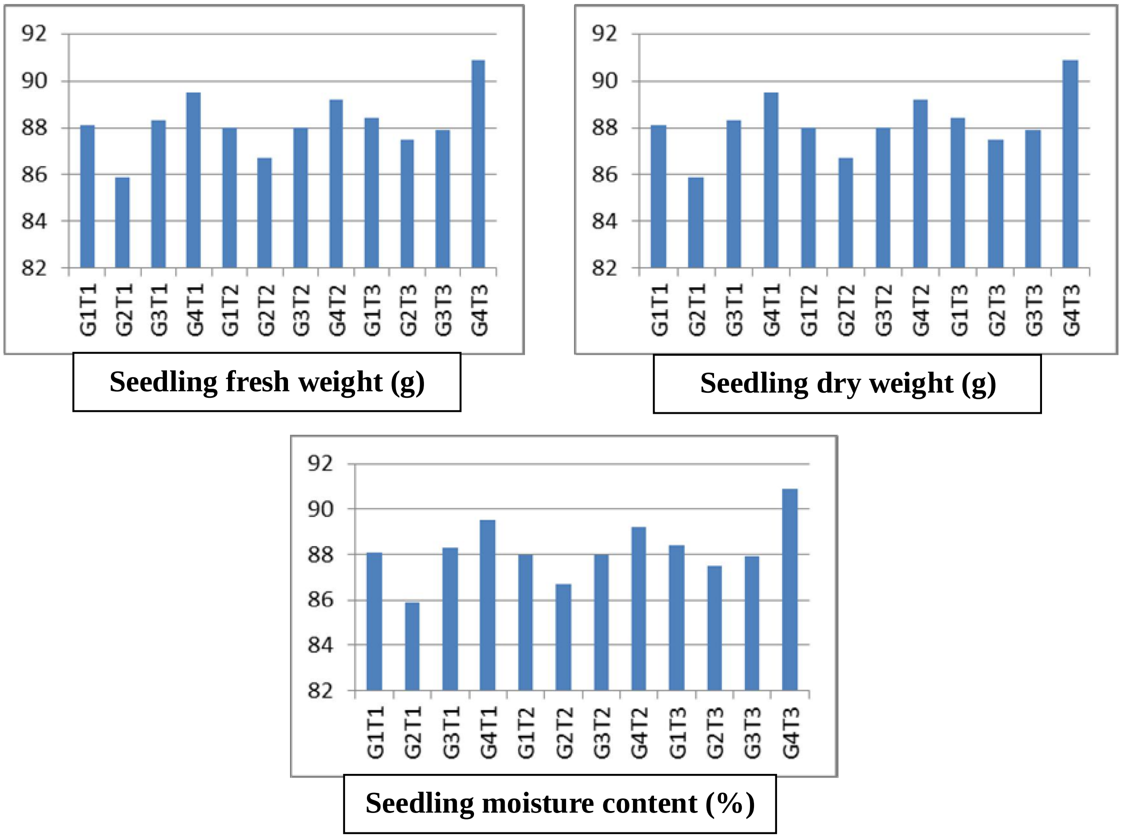


Figure 2. Interaction effect between different growing media and turf grass genotypes for germination attributes.

*G1T1: Perennial rye grass x Garden Soil; G2T1: Tall fescue x Garden Soil; G3T1; Creeping bent grass x Garden Soil; G4T1; Creeping red fescue x Garden Soil; G1T2: Perennial rye grass x Soil + leaf manure 2:1; G2T2: Tall fescue x Soil + leaf manure 2:1; G3T2; Creeping bent grass x Soil + leaf manure 2:1; G4T2 Creeping red fescue x Soil + leaf manure 2:1; G1T3: Perennial rye grass x Sand+ Leaf manure 2:1; G2T3: Tall fescue x Sand+ Leaf manure 2:1; G3T3: Creeping bent grass x Sand+ Leaf manure 2:1; G4T3 Creeping red fescue x Sand+ Leaf manure 2:1

Seed germination necessitates a combination of water, oxygen, and optimal temperature conditions. Water serves to soften the protective seed coat, while oxygen is essential for aerobic respiration, providing the energy required for germination. Additionally, the embryo relies on the breakdown of its stored food for energy. Furthermore, a warm temperature is crucial to expedite the chemical reactions involved in seed growth and the formation of new cells during the embryonic growth process. The observed minimum germination days in Treatment T_2 (garden soil + leaf manure (2:1)) can be attributed to the benefits of using a soil and leaf manure mixture. This combination likely provided aeration, moisture supply, and sufficient porosity, facilitating gaseous exchange between the media and the seeds. These conditions not only increased the germination process but also contributed to enhanced soil fertility, thereby creating an optimal and favourable environment for seed germination. The combination of leaf manure and sand although good for air exchange, but does not hold moisture for long which hampers effective germination [10]. The variations in germination days among grass species align with the inherent characteristics of each species [11]. For instance, the rapid germination of perennial ryegrass is consistent with its reputation for quick establishment. In contrast, the longer germination period for creeping bent may be linked to its inherent genetic potential.

The highest germination percentage recorded in T_1 (soil) and T_2 (Soil + Leaf manure) suggests that these media provide favourable conditions for germination. Soil is rich in nutrients and provides a stable substrate for seed germination, while the addition of leaf manure in T_3 could enhance soil fertility and water retention, contributing to optimal germination conditions. These findings align with Abirami [12] who reported that combination of Soil + Coir pith + Sand + Vermicompost (1:1:1:1) were found to be the best in terms of germination percentage. Similarly, Bhardwaj [13] also noted that the blend of vermicompost and soil led to the highest germination percentage in papaya. The lower germination in T_3 (Sand+ Leaf manure) highlights the importance of substrate composition. Sand, being a less nutrient-rich and well-draining medium, may not provide the necessary support for seed germination compared to soil-based media.

The vigour index observation suggests that the addition of leaf manure to the soil positively impacted the vigour index of the plants, potentially due to the enrichment of nutrients and organic matter in the growing medium. The current findings align with Bhardwaj [13], who demonstrated that the inclusion of vermicompost in combination with pond soil in a nursery setting enhances seedling vigour, creating a favourable environment for the growth and development of papaya. The superior performance of T_2 in comparison to T_1 indicates that the inclusion of leaf manure in the soil can be a beneficial practice for promoting plant vigour.

The observed variation in seedling length, seedling fresh weight and seedling dry weight among different growing media and grass species indicates the significant influence of substrate composition on the initial growth of grass seedlings. The maximum seedling fresh weight in T_2 (Soil + Leaf manure (2:1) suggests that leaf manure and soil together enhance water retention and nutrient release in the growing region, leading to increased production of plant hormones like auxin, gibberellins, and cytokinins that leads to higher proportion of younger roots, promoting root elongation and more root hairs. This, in turn, enhances nutrient absorption from the soil, resulting in increased root and stem length, as well as higher fresh and dry weights in seedling. These results align with the findings of

Abirami *et al* [12], Bhardwaj [13], Chiranjeevi et al [14] and Zaller [15]. As for seedling moisture content, it varies with the germination and more moisture content corresponds to the higher turgidity and more survivability in field. Further in creeping bent grass, superiority of sand based media for improving seedling length and vigor index can be explained by species dependent interaction with media as this grass is used commonly in golf courses and sports turfs where largely sand based media are used. Sand based media with improved gas exchange in the root zone, increases rooting depths and can contribute to better quality above ground. Further, variability in different species can be explained by their inherent genetic potential and varies in their germination potential [16]. Parallel to our findings, Charif et al [17] also observed variations in germination behaviour of five cool season turgfrasses where, perennial rye grass displayed maximum germination rate.

4. CONCLUSION

As per the reported findings above, it can be concluded that if native garden soil is mixed with leaf manure in 2:1 ratio, it enhances germination potential of cool season turfgrass species and for sub-tropical conditions perennial rye grass can be used for over-seeding in cool season as it germinates faster with maximum germination among other cool season grass species.

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AUTHORS' CONTRIBUTIONS

A has planned the experiment, conducted trail and data collection; B has done analysis of the results and written original draft; C was involved in planning of the experiment and execution; D has planned the experiment and edited original draft; E was involved in data analysis and editing of the manuscript. All authors read and approved the final manuscript.

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